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Analysis of Composite Mechanical Strength from Waste Chicken Feather and Sawdust

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Abstract

The objective of the study is to determine the mechanical strength of chicken feather and sawdust waste in making bio composites. The use of natural fibers because they are cheap and environmentally friendly. Preparation of biocomocytes with several volume fractions. Making bio composite with several volume fractions using polyester resin matrix and natural fiber reinforcement of sawdust and chicken feathers. The study was conducted by making 5 volume fraction specimens. Specimen 1 (matrix polyester 80%, chicken feather 20%, and sawdust 0%) specimen 2 (80%,15%,5%) specimen 3 (80%,10%,10%) specimen 4 (80%, 5%, 15%) specimen 5 (80%, 0%, 20%). Testing of bio composites with the American Society for Testing Materials (ASTM) D 3039 specimen standard tensile testing using a universal testing machine. Impact testing using ASTM D 6110-18 standard specimen with impact testing machine Impact testing with ASTM D256 specimen standards with an impact testing machine. From the test results, the volume fraction of matrix polyester 80%, chicken feather 15%, sawdust 5%, has the highest tensile strength with 6,390 MPa. Tensile test at a volume fraction of matrix polyester 80%, chicken feather 15%, sawdust 5% with an impact strength of 0.731 joules. From the research results, it can be concluded that the same volume fraction as the tensile and impact test has a high mechanical strength. The use of the dominant fiber does not affect its mechanical strength.

Keywords: *Bio composite; chicken feathers; mechanical strength; volume fraction*

1. Introduction

The practical and instantaneous behavior of modern society also adds to the waste production figure. Efforts are needed to utilize waste in order to have added value. The creative industry sector plays a role in processing waste into useful products. Alternative waste treatment in the manufacture of environmentally friendly and biodegradable materials. The alternative use of biodegradable plastics and bio composites is gaining popularity because they are easily degraded by the environment. Natural fibers have the advantage of being reinforced in the manufacture of composites Composite materials replace conventional materials because natural fibers have low density, are relatively light and have high specific properties and are environmentally friendly. The percentage of fiber in the manufacture of bio composites results in substantial variation in the heat transfer properties of the insulation and natural fibers have the advantage of being less expensive than synthetic fibers [1][2]. The main drawbacks of natural fibers are the compatibility between the fibers and the uneven matrix and their relatively high moisture absorption. Processing of bio composite materials are administered by combining natural fibers with polymers that are biodegradable. Hemp fiber hybrid yarn bio composite wrapped in PLA filaments with varying masses of 10 to 45% and PLA filaments 150 and 250 turns/m of mechanical testing result showed that the tensile and flexural strengths increased to 59.3 and 124.2 Mpa and the impact strength was 26.3 Kj/M2 with the addition of fibers up to a mass of 45% [3].

Materials have an important role in the continuity of the life cycle of the manufacturing industry in various fields. A big challenge for the industry to innovate to replace materials with limited resources to become sustainable materials and to increase awareness of the environment. Green composites have thermal-mechanical properties comparable to polypropylene, hopefully they can be used in manufactured products for packaging, vehicle parts, furniture and residential applications [4]. The replacement of synthetic fibers with natural fibers provides many benefits and is safe for the environment. The thermal properties of the matrix, chemical composition and physical properties identify the initial stages of the bio composite manufacturing process. The nature of natural fiber polymer composites is influenced by the type of fiber, fiber composition, fiber volume, fiber size/orientation and the manufacturing process of the composite. The combination of optimal fiber lengths of 20-30 mm reduces voids between fiber and matrix resulting in good tensile and flexural properties [5].Composites are reinforced with various types of fibers such as glass fibers, carbon fibers or natural fibers and polymers as a matrix, which are plastic, resin, rubber or metal.

Chicken feathers contain about 91% protein (keratin), 1% lipids, and 8% water. Chicken feather fibers with alpha helical structure at the molecular level are light and strong enough to withstand mechanical and thermal stresses. Aspen fiber medium density fiberboard composite panel with replacement of bristles in amounts ranging from 20% to 95% and 5% phenol formaldehyde used as adhesive [6]. Manufacture of composite sandwich blocks made of all natural materials to develop 100% structural composites [7]. Chicken feather composite paper is made of 51% feather fiber and 49% wood pulp, only half a tree is needed to produce it [8].

Wood is a versatile raw material that plays an important role in everyday life. Wood is more flexible in many applications. Wood Plastic Composites (WPC) is an alternative to minimize the use of wood. NPCB-reinforced wood composites are thermally stable at temperatures below 200°C and with an increase in the tensile strength of the composite to 32.4 MPa [9]. Their wide availability, wood fibers offer a real alternative to bio composite fibers. Global demand for fibrous materials and awareness of the environment, research on the development of composites with various kinds of waste materials is being conducted [10]. Utilization of green waste materials as reinforcement in WPC production reduces shortages of timber resources, and has the potential to start natural fiber industries in countries with little or no timber resources [11]. The increase in the use of bio composites in materials engineering is due to the issues regarding the impact on the environment and the sustainability of fiber sources. Treatment of natural fibers can be used to strengthen various types of polymers, into a type of composite material known as eco-composites or bio composites. Modification with the chemical sodium hydroxide, acetic acid, peroxide can increase the bond between matrix and fiber and reduce water absorption thereby increasing fiber strength, suitability of natural fiber composite fibers [12]. The use of epoxy resin due to its high mechanical and thermal properties, good toughness, water resistance, low shrinkage rate, and easy fabrication.

Electronic applications use quill fiber with several compositions used in the manufacture of high-speed data converter insulators with a constant dielectric range of 4.5-1.7 depending on the fraction of the feather and temperature conditions [13]. Natural fiber reinforced composites can be used in the manufacture of several components of automotive, marine, consumer products, defense aerospace and industrial packaging to reduce material costs. Natural fiber composite manufacturing processes are being developed using hand layup, vacuum bag, pultrusion, extrusion, compression molding, filament winding, and injection molding methods. Manufacture of fiber composites and epoxy resin matrix with lower compressive and tensile strength than fiber composites and polyester resin then the energy absorption and impact strength of fiber fibers and epoxy matrix have higher values than fiber fibers and polyester matrix [14]. The purpose of making bio composites is to determine the potential utilization of chicken feather waste, wood powder, and polyester matrix as bio composites and to determine the mechanical strength of each waste volume fraction.

2. METHODS

This research is a process of making bio composite with natural fibers from chicken feather waste and sawdust with polyester resin matrix. The waste of chicken feathers and sawdust was cleaned and dried. The mold was made using a steel plate with a thickness of 8 mm with a rectangular shape used for making the specimen. Making bio composite was performed by mixing the waste material according to the volume fraction which has been planned in making the specimen. The mixed waste material was then put into the mold and then carried out by compression molding. Pressing the mold in the manufacture of all specimens using a hydraulic press with a pressure of 1000 kg. The volume fractions of resin polyester, chicken feathers and sawdust can be seen in Table 1.

Table 1. Bio composite Volume Fraction

No	Resin polyester	Chicken Feather	sawdust
1	80%	20%	0%
2	80%	15%	5%
3	80%	10%	10%
4	80%	5%	15%
5	80%	0%	20%

The process of making bio composites using compression techniques used a hydraulic press. Compression printing also has advantages such as less waste and low cost, high productivity, and low cycle times. Mechanical testing of materials includes many experimental methods. The mechanical properties of the bio composite can be determined by tensile testing. Testing using a universal testing machine (UTM) servopulser with a maximum capacity of 2000 kg. The speed of specimen withdrawal can be varied. The test specimen size is in accordance with American Standard Testing and Material (ASTM D3039) [15]. The test was administered as many as 5 specimens according to each volume fraction. Impact testing using rapid loading and dynamic loads. The results of the impact test were to determine the strength and ductility of bio composites. For each volume fraction, two test specimens were made. Impact testing used an impact testing machine with American Standard Testing and Materials (ASTM D256) [16]. The impact test was conducted as many as 10 test specimens.

2.1 Standard ASTM D3039

Tensile testing uses the ASTM D3039 standard (Standard Test Method for Tensile Properties of Polymer Matrix Composite Materials) the dimensions of the tensile test specimen with a length of 250 mm, width 25 mm, thickness 2.5 can be seen in the picture

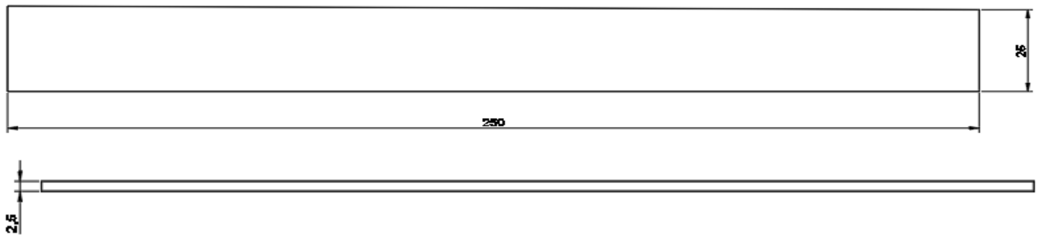


Figure 1. Tensile Test Specimen ASTM D3039

Figure 2. Test Specimen Tensile

2.2 Standard ASTM D256

Impact testing using standard ASTM D256 (Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics) specimen dimensions can be seen in Figure 3.

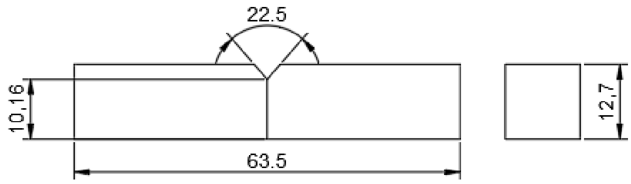


Figure 3. Dimensions Izod Type Test Specimen

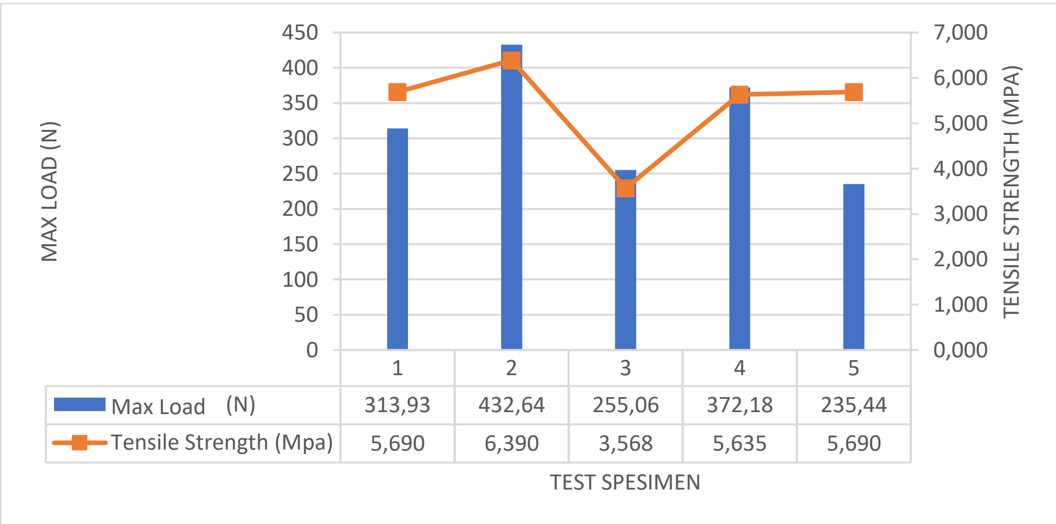
Figure 4. Test Specimen Izod

3. Result and Discussion

Tensile and flexural testing is an initial investigation of the characteristics of bio composites in the process of making a product application. Tensile testing is carried out using the ASTM D3039 standard. The results measured are tensile strength and maximum load. Impact testing with ASTM D256 standard, the measured result is the impact energy. There are 5 volume fractions planned for each test.

3.1 Tensile Testing

The results of the tensile test showed an increase in the tensile strength of the bio composite with the addition of sawdust to the volume fraction. The addition of 5% sawdust and 15% chicken feathers in specimen 2 can increase the tensile strength to 6.390 MPa and the maximum load is 432.64 N. The addition of 15% chicken feathers and 5% sawdust can increase the maximum load by 371.18 N. The results of the test can be seen in Figure 1.

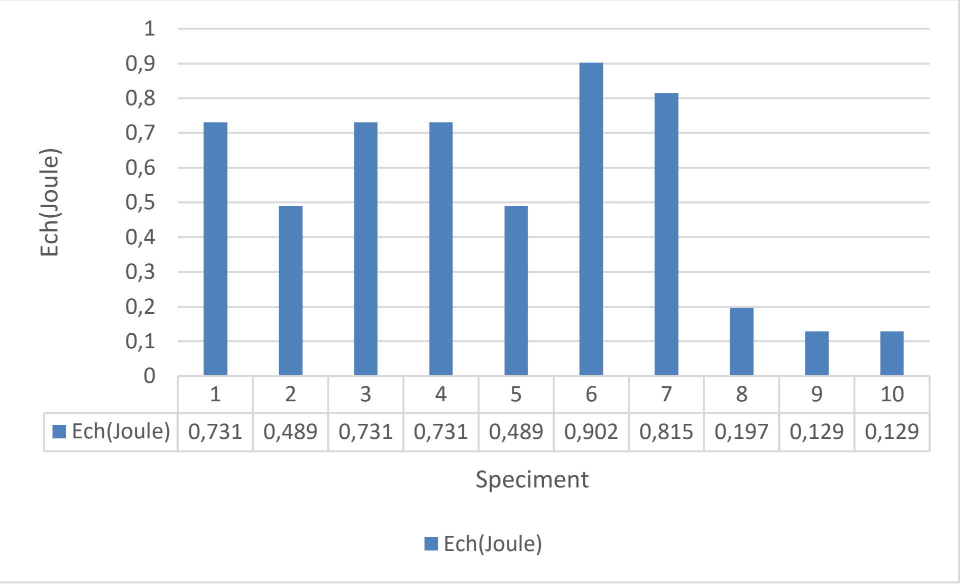


Graph 1. Tensile Testing Results

The volume fraction 2 with 80% polyester resin, 15% chicken feather, and 5% sawdust has optimal tensile strength and maximum load from several test specimens. The addition of sawdust can increase the bond between the matrix and the reinforcement so that it can increase the mechanical strength due to the uniform stress distribution. Increasing the volume fraction of the reinforcement can reduce the deformation that occurs because the load that occurs will be borne by the matrix and reinforcement of the bio composite.

3.2 Impact Testing

Impact testing was carried out 10 times with 2 specimens from each volume fraction. The results of the impact test showed that the composite with a volume fraction of 80% polyester resin, 15% chicken feather, and 5% sawdust had an impact energy of 0.731 Joules.



Graph 2. Impact Testing Results

The volume fraction 2 in the impact testing of specimens 3 and 4 shows a combination of matrix and reinforcement and the pressure forms a strong bond resulting in impact energy of 0.731 Joules. The volume fraction 3 with 10% sawdust with specimens 5 and 6 had an impact energy of 0.695 joules. The volume fraction with reinforcement that dominates 20% chicken feather in specimens 1 and 2 has smaller impact energy than volume fractions 2 and 3. The addition of sawdust in each volume fraction gives an increase in impact energy on each specimen. The volume fraction 5 with specimens 9 and 10 had a low tensile strength of 0.129 Joules due to the absence of addition of chicken feathers. The combination of the composition of chicken feather reinforcement and sawdust is an indicator of increased mechanical strength.

4. Conclusion

The process of making bio composites using a combination of polyester resin, chicken feather waste, and sawdust has been made according to the planned volume fraction. The study was conducted to determine the potential utilization of chicken feather waste and sawdust in the manufacture of bio composites and to determine the mechanical strength of each volume fraction of the waste used.

The data from the tensile and impact tests of bio composites have varying mechanical strength according to the volume fraction. The volume fraction with 80% polyethylene resin, 15% chicken feather, and 5% sawdust has optimal mechanical strength from tensile and impact tests. Tensile testing of bio composites with an optimal level of 6390 MPa and impact testing with a value of 0.731 joules of all volume fractions. The results obtained from all specimens with tensile and impact tests can be seen at the same volume fraction and then produce optimal mechanical strength.

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