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JOURNAL OF APPLIED MECHANICAL ENGINEERING AND RENEWABLE ENERGY (JAMERE)

Vol. 3 No. 1 Februari 2023 23 –27 ISSN : 2775-1031

Composite Material Impact Test With Resin Matrix And Kenaf Fiber Reinforcement Using The Hand Lay Up Method

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Abstract
The purpose of this study was to obtain the results of impact testing on composite material with the arrangement of kenaf fibers in woven with volume variations of 0%, 10%, 20%, 30%, 40%, and 50%. The value obtained from impact testing with 0% fiber variation has an average energy absorption yield of 1.730623009 J and an average impact price of 0.01273547 J/mm², 10% fiber has an average absorption energy yield of 1.468150063 J and an average yield of 1.468150063 J The average impact price is 0.01080396 J/mm², 20% fiber has an average energy absorption yield of 1.730623009 J and an average impact price is 0.01273547 J/mm², 30% fiber has an average energy absorption yield of 1.214516698 J and the average yield is 1.214516698 J The average impact price is 0.008937499 J/mm², 40% fiber has an average energy absorption yield of 1.993095955 J and an average impact price is 0.01466698 J/mm², 50% fiber has an average energy absorption yield of 2.264328531 J and an average yield of 2.264328531 J Average Impact Price 0.016662952 J/mm². This composite material is made with epoxy resin as a binder and kenaf fiber as a reinforcing material. The method used is hand lay-up and specimen testing using charpy impact. After testing, a micro photo will be taken to see the best specimen fracture results.

Keywords: *composite, kenaf fiber, epoxy resin, hand lay-up, impact, micro photo.*

1 Introduction

At this time the use and utilization of composites continues to develop in the field of science and technology in the industry starting to make it difficult for conventional materials such as metals to meet the needs of new applications. The aircraft manufacturing industry, shipping, automobiles and the transportation industry are examples of industries that currently apply materials that have low properties, are rust-resistant, sturdy, resistant to wear and tear and are inexpensive as industrial raw materials [1]. Composite materials from natural fiber reinforcing materials continue to be researched and developed to be an alternative material to replace composites from synthetic fiber materials. This is due to several advantages that natural fibers have such as being environmentally friendly, low density, recyclable, biodegradable, non-toxic, and low material processing costs [2]. Natural fibers are types of fiber as raw materials for the textile industry or others, which are obtained directly from nature [3].
The use of natural fibers as reinforcement for composite materials is very necessary to reduce the negative effects produced by composite materials with synthetic reinforcement. Natural fibers have the characteristics of being light, easy to obtain, easy to process, non-abrasive,
low density, low cost, has a relatively good strength value, and is easy to recycle.

2 Literature Review

Composite is a material formed by combining two or more materials to produce a composite material that has different mechanical properties and characteristics from the constituent materials. Composites have better mechanical properties than metals, specific stiffness (Young's modulus/density) and higher specific strength than metals. The purpose of forming composites is to improve mechanical properties and facilitate difficult designs in manufacturing, flexibility in the form of designs that can save costs, and make the material lighter [4]. The fiber used in this study is kenaf fiber (Hibiscus cannabinus), commonly known as Javanese jute, which is a natural fiber that can be developed as a composite reinforcement material. Of the several types of variation characteristics of kenaf fiber for long fiber the average data is greater than with short fibers [5].

Kenaf fiber is generally only used as a burlap sack material, so its use as a composite material needs to be developed in order to increase its economic value and usefulness. World kenaf fiber production reaches 229,700 tons/year at a price of 0.55USD/kg, kenaf fiber is cheaper when compared to E glass fiber prices 3.25 USD/kg and carbon fiber 200 USD/kg [6]. The manufacturing method used in this study is the hand lay-up method, which is the easiest method in the manufacturing process. As for the process of Making composites with this method is pouring the resin into the fibers that have been arranged in the mold [7].

This study used epoxy resin as a binder. Epoxy resins have been widely used for coatings, electronic materials, adhesives, and matrices or binders for fiber reinforced composites because of their excellent mechanical properties, high adhesive strength, good heat resistance, and high electrical resistance [8].

Epoxy resin has advantages according to Epoxy resin has good adhesive properties for fiber and resin, chemical resistance and acid stability, high flexibility and strength, and corrosion resistance [3].

2.1 Formula Calculation

The formula for calculating absorption energy is:

$$\text{Absorb Energy} = Ep - Em$$
$$= m \,.\, g \,.\, h_1 - m \,.\, g \,.\, h_2$$
$$= m \,.\, g \,.\, (h_1 - h_2)$$
$$= m \,.\, g \,.\, (h - R \,.\, cos\,\alpha) - (m.g.(h - R \,.\, cos\,\beta)$$
$$\text{Absorb Energy} = m \,.\, g \,.\, R\ (cos\,\beta - cos\,\alpha)$$

Impact value formula:

$$Value\ Impak\ (Joule/mm^2) = \frac{Energi\ Serap}{A}$$

Information :
ES: Absorbed Energy (J)
Ep: Potential energy
Em: Mechanical energy
m: Mass of the pendulum (kg)
g: gravity (9.81 m/s²)
h: The initial distance from the pendulum to the test object (m)
h²: The final distance of the pendulum with the test object(m)
R: Swing arm distance (m)
α: Pendulum angle before swing
β: Pendulum angle after breaking the specimen

2.2 ASTM Used In This Study

The test used in this study is the impact test, Impact is a test measuring the strength of the material against impact by pounding the specimen using a pendulum. The impact method used is charpy impact with ASTM D 6110-04 [9].

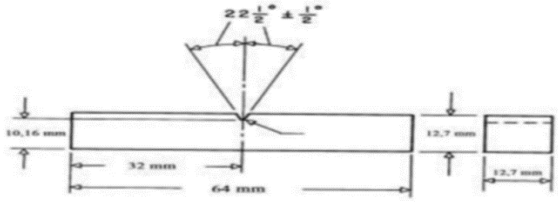


Fig 1 Impact Test Dimensions Based On ASTM D 6110-04

2.3 Tools And Materials

1. Kenaf fiber (woven arrangement)
2. Polyamide epoxy resin
3. Astm compliant acrylic molding
4. Magic gloss
5. Brush
6. Sandpaper
7. Plastic cups
8. Triangle files
9. Calipers
10. Digital scales
11. Mailing machine
12. Impact test
13. Microscope for micro photo test

2.4 Specimen Manufacturing Stage

1. Prepare tools and materials.
2. Kenaf fiber will be woven and cut according to ASTM standard.
3. Apply the mold with Miracle Gloss using a brush evenly to make the composite easier to remove from the mold.
4. Mix the resin and hardener into a plastic cup with a ratio of 50:50.
5. Pour the resin into the mold and smooth it out using a brush until the entire mold area is filled.
6. The woven fiber is put into a mold containing resin, then filled with resin until evenly distributed with the mold.
7. Next, allow the resin-filled mold to dry.
8. After the specimen has been finished, do impact testing and micro photos

2.5 Research Flowchart

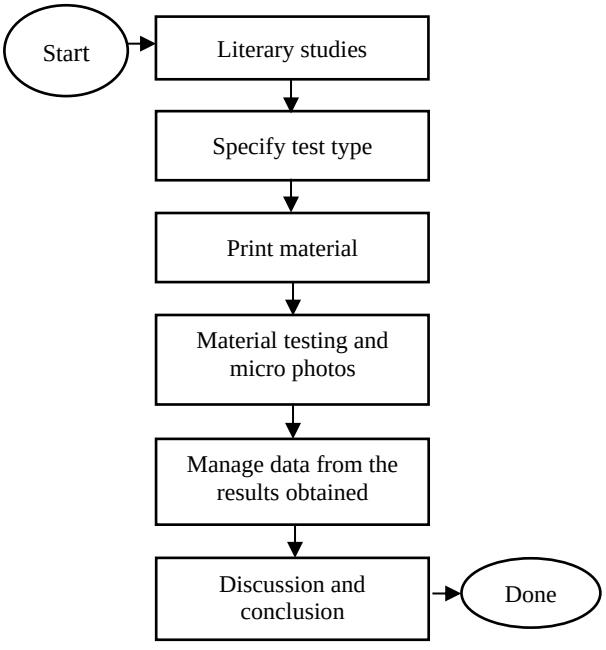


Fig 2 Research Flowchart

2.6 Place And Time Of Research

Impact testing was conducted at the College of Aerospace Technology (STTKD) and Gadjah Mada University (UGM). This research was conducted from January 2022 to July 2022.

3 Results and Discussions

Impact Test Composite Specimen Results

Table 1 Specimen pictures after testing

Specimen Variation	Specimen pictures after testing
0% fiber	
10% fiber	
20% fiber	
30% fiber	
40% fiber	
50% fiber	

Based on the results of the impact test on the kenaf fiber reinforcing resin matrix composite, data obtained in the form of angle α is the initial position of the pendulum and angle β is the final position of the pendulum. then the absorption energy and impact value will be calculated using the charpy impact formula according to the ASTM D 6110-04 standard.

3.1 The Calculation Results

Table 2 Impact test results of 0% fiber specimen

volume fraction	α(°)	β (°)	ES (J)	HI (J/mm²)
0%	156	152	1.99309596	0.01466698
fiber	156	153	1.468150063	0.01080396
Average			1.730623009	0.01273547

From the table above, the volume variation is 0% fiber and 100% resin, the first specimen gets an Absorb Energy result of 1.99309596 J and gets an Impact Price of 0.01466698 J/mm² and for the second specimen gets an Absorb Energy result of 1.468150063 J and gets the result Price The impact is 0.0108039596 J/mm².

Table 3 Impact test results of 10% fiber specimen

volume fraction	α (°)	β (°)	ES (J)	HI (J/mm²)
10%	156	153	1.468150063	0.01080396
fiber	156	153	1.468150063	0.01080396
Average			1.46815006	0.01080396

From the table above that the volume variation of 10% fiber and 90% resin, the first specimen gets an Absorb Energy result of 1.468150063 J and gets an impact price of 0.0108039596 J/mm² and for the second specimen gets an Absorption Energy result of 1.468150063 J and gets the result Price The impact is 0.01080396 J/mm².

Table 4 Impact test results of 20% fiber specimen

volume fraction	α (°)	β (°)	ES (J)	HI (J/mm²)
20%	156	153	1.468150063	0.01080396
serat	156	152	1.99309596	0.146669803
Average			1.730623009	0.01273547

From the table above that the volume variation of 20% fiber and 80% resin, the first specimen gets an Absorb Energy result of 1.468150063 J and gets an Impact Price of 0.01080396 J/mm² and for the second specimen gets an Absorb Energy result of 1.9309596 J and gets an Impact Price result. i.e. 0.01466698 J/mm².

Table 5 Impact test results of 30% fiber specimen

volume fraction	α (°)	β (°)	ES (J)	HI (J/mm²)
30%	156	154	0.96088333	0.007071038
fiber	156	153	1.468150063	0.01080396
Average			1.214516698	0.008937499

From the table above, the volume variation is 30% fiber and 70% resin, the first specimen gets an Absorb Energy of 0.96088333 J and gets an Impact Price of 0.007071038 J/mm² and for the second specimen gets an Absorb Energy result of 1.468150063 J and get the result that the Impact Price is 0.01080396 J/mm².

Table 6 Impact test results of 40% fiber specimen

volume fraction	α (°)	β (°)	ES (J)	HI (J/mm²)
40%	156	152	1.99309596	0.01466698
fiber	156	152	1.99309596	0.01466698
Average			1.99309596	0.01466698

From the table above that the volume variation is 40% fiber and 60% resin, the first specimen gets the Absorb Energy result which is 1.99309596 J and gets the Impact Price result which is 0.01466698 J/mm² and for the second specimen gets the Absorb Energy result which is 1.99309596 J and gets the result Price The impact is 0.01466698 J/mm².

Table 7 Impact test results of 40% fiber specimen

volume fraction	α (°)	β (°)	ES (J)	HI (J/mm²)
50%	156	151	2.53556111	0.018658923
fiber	156	152	1.99309596	0.01466698
Average			2.264328531	0.016662952

From the table above that the volume variation is 50% fiber and 50% resin, the first specimen gets the Absorb Energy result which is 2.53556111 J and gets the Impact Price result that is 0.018658923 J/mm² and for the second specimen gets the Absorb Energy result

which is 1.99309596 J and gets the result Price The impact is 0.01466698 J/mm².

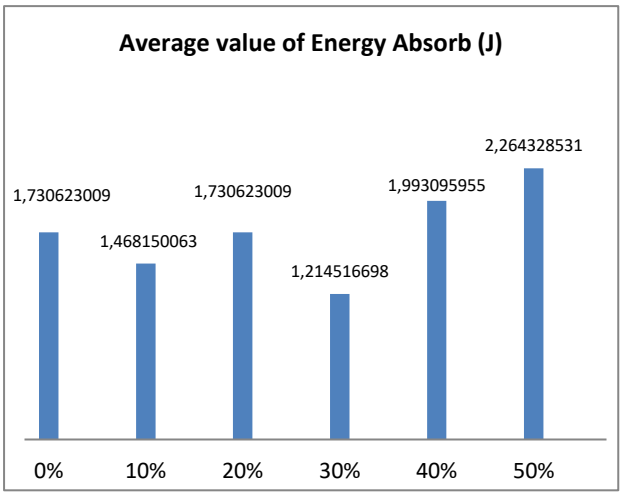


Fig 3 Graph of the average value of Absorb Energy for each variation

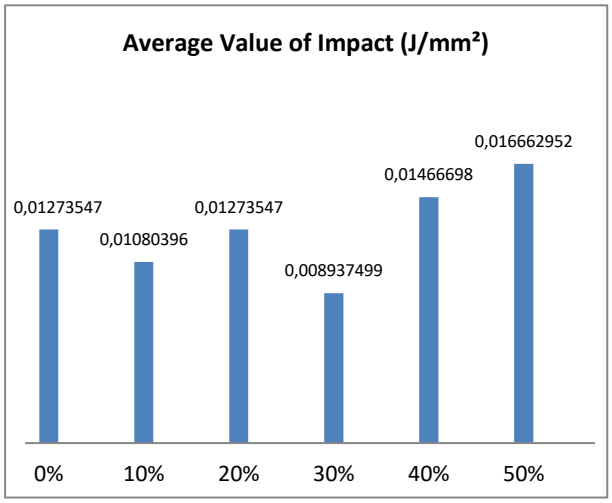
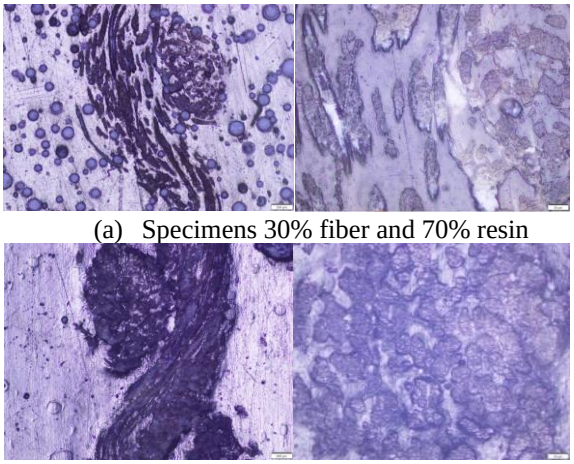


Fig 4 Graph of the average value of the impact for each variation

From the graph above, it can be concluded that it is better to use a volume variation of 50% fiber compared to other volume variations, because the largest value of all volume variations is 50% fiber, with an Absorb Energy value of 2.264328531 J and an Impact Price value of 0.016662952 J/mm². for the lowest value of specimen testing is 30% fiber with an Absorb Energy value of 1.214516698 J and an Impact Price value of 0.008937499 J/mm².

3.2 Micro Photo Test Results



(a) Specimens 30% fiber and 70% resin

(b) Specimens 50% fiber and 50% resin

Fig 5 Micro Photo Test Results (a) Specimens 30% fiber and 70% resin (b) Specimens 50% fiber and 50% resin

In the picture above analyzes the 30% fiber specimen and 50% fiber using Photo Micro 50x and 200x, in the 30% fiber specimen there are still many voids so that when the impact test gets a low value and makes the specimen brittle, for the 50% fiber specimen it has large voids. less, so that when the impact test gets a high value compared to other volume variations and makes the specimen ductile. on the results of other studies that are similar, the characteristics of the kenaf fiber composite in the Strength test the best results were obtained in the fiber volume fraction at 40% volume fraction [10].

4 Conclusion

From this study, the characteristics of kenaf fiber in the Impact Test with a variation of 0% fiber have an average value of absorption energy of 1.730623009 J and an average value of impact price of 0.01273547 J/mm², 10% fiber has an average value of absorption energy of 1.468150063 J and the average value of Impact Price is 0.01080396 J/mm², 20% fiber has an average energy absorption value of 1.730623009 J and the average value of impact price is 0.01273547 J/mm², 30% fiber has an average energy absorption value of 1.214516698 J and the average value of the impact price is 0.008937499 J/mm², 40% fiber has an average energy absorption value of 1.993095955 J and the average value of the impact price is 0.01466698 J/mm², 50% fiber has an average energy absorption value of 2.264328531 J and the average value of Impact Price is 0.016662952 J/mm². From the results of this study, the best volume variation composition was 50% fiber and the worst volume variation composition was 30% fiber.

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