Proceeding – CAMIC

Cirebon Annual Multidisciplinary International Conference (CAMIC 2024)

Study Of Mechanical Properties The Effect Adding Sugarcane Fiber To Polyester Matrix Composites

1st Rusnoto
Faculty of Engineering and Computer Science
Pancasakti of University Tegal
rusnoto74@gmail.com

2nd Oka Firzha Adhitya
Faculty of Engineering and Computer Science
Pancasakti of University Tegal

3rd Soebyakto
Faculty of Engineering and Computer Science
Pancasakti of University Tegal

***Abstract*—Composite is a combination of two or more materials that form a new material. The components of the composite are matrix elements and reinforcing to become a material. The purpose of this study was to determine the mechanical strength of composites with sugarcane fiber reinforcement of 0%, 1.5%, 2.5%, and 3.5% on tensile strength, bending strength, and impact strength of polyester matrix composites. The technique for making the composite uses hand lay up. The materials used include sugar cane fiber, polyester resin, hardener. The tools used are resin molds, wire brushes, paint brushes, cutting tools, and scales. The research method is by adding polyester resin to 0%, 1.5%, 2.5%, and 3.5% sugar cane fiber, then dried using solar heat. After that, tensile tests, bending tests, and impact tests are carried out. The results of testing the mechanical properties of sugar cane fiber composite materials, with the results of the largest average tensile test data on the addition of 0% fiber of 30.1 N/mm^2, so that the addition of sugar cane fiber does not have a significant effect on tensile strength. In the bending test results produces the highest average bending strength at the addition of 1.5% sugarcane fiber of 27.09 N/mm^2, so that the addition of sugarcane fiber has a significant effect on bending strength. In impact strength, it produces the highest strength at the addition of 3.5% sugarcane fiber, which is 0.016 N/mm^2, so that the addition of sugarcane fiber has a significant effect on impact strength.**

Keywords— ***composite; polyester; sugarcane fiber; tensile test; bending test; impact test***

I. INTRODUCTION

Indonesia is a country with abundant biological natural resources that need to be used wisely for the prosperity of the people. One of them is sugar cane stalks whose juice has been extracted as raw material for sugar and then the fiber can be used as a polymer composite material. Where if sugarcane fiber is not used properly it will cause problems including polluting the environment because the material is flammable. Apart from that, sugarcane fiber also has a fairly high content which can be used as a reinforcement in the production of compounds used as raw materials for the bio-composite industry. Where sugar cane fiber contains cellulose lignin and the fiber length is approximately 30 – 120 mm and a diameter of 20 micrometers and has a sugar content of 3.3%, water content of 46 – 52%, and an average fiber content of 47.7%.

Taking natural fibers found in sugar cane husks and bonding them with polyester resin reinforcement, where bio composites are composite materials that combine two or more with different material compositions into one material. The main ingredient in composite materials is a matrix whose mechanical properties are improved using good reinforcement materials to minimize fiber detachment from the matrix (fiber pull out). The matrix used is polyester polymer in making sugarcane fiber composites. Reinforcement is a reinforcement made from natural fibers, synthetic fibers and natural particles or natural powders. Reinforcement can be classified into three, namely: fiber composites, particulate composites and laminated composites. The reinforcing material is sugar cane fiber.

Sugarcane fiber was chosen as a composite material because it has a strong material structure and light weight, and combined with polyester resin, it is suitable for use as a basic material for making motorbike bodies. The motorbike body is an important component for protecting the vehicle frame, protecting the driver from the heat of the vehicle engine and vehicle exhaust, adding aesthetics and selling value. So as time goes by, motorbike vehicle bodies have various shapes and accessories, which causes competition between bodywork

companies to continue to increase and triggers the creativity of motorbike body designers. This means that the combination of sugar cane fiber composite with polyester resin is something new that needs to be studied and the results can be seen so that the application affects the motor body with better results or not and will help ensure a high quality motor body.

The aim of this research was to determine the addition of 0%, 1.5%, 2.5%, 3.5% of sugar cane fiber on the tensile strength, bending strength, impact strength.

II. METHOD

The materials used are polyester resin and sugar cane fiber. The equipment used is digital scales, molds, wire brushes, stamps, paint brushes, rulers, hacksaws, tensile testing machines, bending tests and impact tests. This research uses an experimental method by varying the comparison of sugarcane fiber by 0%, 1.5%, 2.5% and 3.5% which involves tensile, bending and impact testing to determine the results. The way to make a motorbike fairing is by making a mixture of resin with a catalyst, then applying the resin with a brush to the mold. After that, add sugar cane fiber as a strengthening material, after all the ingredients have been mixed together in the mold then dry in the sun for 2 days. When it is dry, lift the fairing from the mold.

Tensile testing is a test that determines the strength of a material in reducing a certain tensile force. Tensile testing is destructive because the composite sample is subject to continuous tensile strength until the sample elongates and finally breaks (Callister, 1991).

$$\sigma = \frac{P\ max}{Ao} \quad \text{..... (1)}$$

Information :
σ = Tensile Stress (N/mm2)
$Pmax$ = Maximum load (N)
Ao = Cross-sectional area (mm2)

Bending testing is a process carried out by pressing the test with the aim of obtaining results in the form of data regarding the bending strength of the material being tested. Bending strength or Modulus of Rupter can be calculated using the following formula (Callister, 1991).

$$\sigma b = \frac{3\ x\ P\ max\ x\ L}{2\ x\ b\ x\ d^2} \quad \text{..... (2)}$$

Information :
σb = Bending stress (N/mm2)
$Pmax$ = Maximum load (N)
b = Width (mm)
d = Thickness (mm)

Impact testing is a test used to determine the firmness of polymer materials. Where in impact testing there are two types

of testing methods including the Izod method and the Charpy method (Callster, 1991).

HI = E/A ..... (3)
Information :
HI = Impact Price (J/mm2)
E = Absorbed Energy (J)
A = Cross-sectional area (mm2)

III. RESULTS AND DISCUSSION

In this research, several tests were carried out, including tensile tests, bending tests and impact tests.

Tensile Test

The tensile test results on sugar cane fiber composite specimens using the ASTM D638 standard and the Universal Testing Machine brand Tensile testing machine can be seen in the Tensile test results in table 1 which shows the results of 12 specimens, consisting of 3 specimens with each variation, including raw materials, 1.5% sugarcane fiber, 2.5% sugarcane fiber, 3.5% sugarcane fiber.

TABEL 1. TENSILE TEST RESULTS

No.	Specimen	Wide (mm)	Long (mm)	A_o (mm^2)	Pmax (KN)	Pmax (N)	ΔL (mm)	Reg. (%)	σ (MPa)
1.	Raw	10,34	12,87	133,07	5,27	5,270	0,67	1,34	39,60
2.	Raw	10,34	11,69	120,80	2,84	2,840	0,52	1,04	23,50
3.	Raw	10,51	13,25	139,25	3,80	3,800	0,74	1,48	27,29
Average									30,1
4.	1,5%	10,36	12,74	116,44	2,15	2,150	0,73	1,68	12,97
5.	1,5%	10,20	12,86	124,76	3,23	3,230	1,32	1,52	19,56
6.	1,5%	10,33	13,10	110,41	3,19	3,190	1,94	1,34	14,04
Average									15,5
7.	2,5%	9,91	11,75	131,98	1,51	1,510	0,84	1,46	16,29
8.	2,5%	10,16	12,28	131,17	2,44	2,440	0,76	2,46	24,62
9.	2,5%	9,56	11,55	135,32	1,55	1,550	0,67	3,88	23,57
Average									21,5
10.	3,5%	10,3	11,92	122,77	2,17	2,170	0,96	1,92	17,67
11.	3,5%	10,23	11,95	122,24	3,01	3,010	0,34	0,68	24,61
12.	3,5%	10,17	12,10	123,05	3,58	3,580	0,24	0,48	29,09
Average									23,8

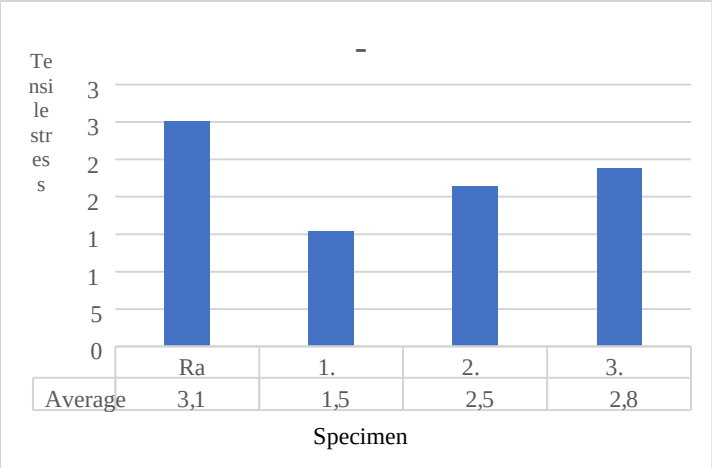

Figure 1. Average Tensile Test Results

Data analysis of sugarcane stem fiber composites on tensile strength. Fig 1, shows that the polyester resin matrix composite with 1.5%, 2.5% and 3.5% sugar cane fiber reinforcement material produces the largest average stress data at 3.5%, experiencing an increase in tensile strength. The highest tensile strength in the 3.5% fraction was 23.8 N/$mm2$. Meanwhile, the 1.5% fraction experienced a decrease of 15.5 N/$mm2$. So the addition of sugar cane fiber has no effect on tensile strength.

Bending Test

The results of bending tests on sugar cane fiber composite specimens using the ASTM D638 standard and the Universal Testing Machine brand bending test machine can be seen in the Tensile test results in table 2 which shows the results of 12 specimens, consisting of 3 specimens with each variation, including raw materials, 1.5% sugarcane fiber, 2.5% sugarcane fiber, 3.5% sugarcane fiber.

TABEL 2. BENDING TEST RESULTS

No.	Specimen	Wide (mm)	Longr (mm)	$Pmax$ (KN)	$Pmax$ (N)	L (mm)	Deflection (mm)	Bending stress (MPa)
1.	Raw	10,04	40,14	0,48	480	100	3,24	17,79
2.	Raw	10,28	40,01	0,58	580	100	3,07	20,58
3.	Raw	10,48	39,86	0,49	490	100	2,98	16,79
Average								18,39
4.	1,5%	9,82	40,34	0,79	790	100	3,81	30,46
5.	1,5%	10,03	39,54	0,70	700	100	3,71	26,40
6.	1,5%	9,37	39,17	0,56	560	100	4,31	24,43
Average								27,09
7.	2,5%	10,02	39,67	0,56	560	100	2,45	21,09
8.	2,5%	9,44	40,40	0,57	570	100	3,33	23,75
9.	25%	9,62	39,76	0,60	600	100	2,94	2,46
Average								23,10
10.	3,5%	9,98	39,90	0,60	600	100	2,94	24,46
11.	3,5%	10,23	39,94	0,48	480	100	2,54	17,23
12.	3,5%	9,88	40,51	0,49	490	100	2,56	18,59
Average								19,99

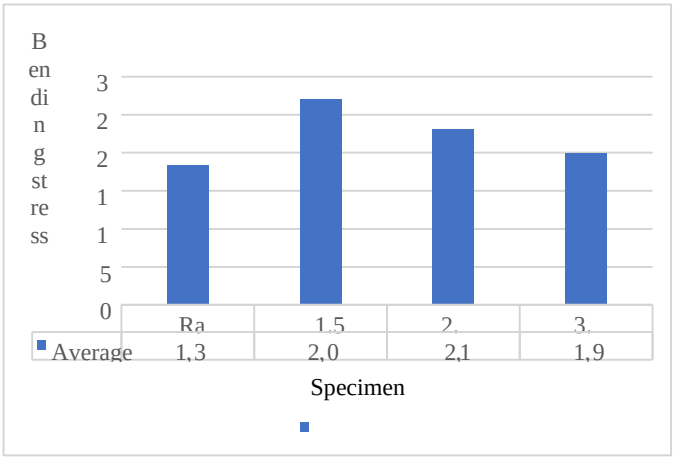

Figure 2. Average Bending Test Results

Data analysis of sugar cane fiber composites on bending strength. Fig 2, shows that the polyester resin matrix composite with 1.5%, 2.5% and 3.5% sugarcane stem fiber reinforcement material produces the largest average stress data in the 1.5% fraction of 27.09 N/$mm2$ whereas in the 3.5% fraction there

was a decrease of 19.99 N/$mm2$, so the addition of sugarcane stem fiber on bending strength was very influential.

Impact Test

TABEL 3. IMPACT TEST RESULTS

No.	Specimen	α(°)	Energy	β(°)	E (J)	Wide (mm)	Long(mm)	Area (mm^2	HI(J/mm^2
1.	Raw	30	21	29,0	1,4	9,88	10,80	106,7	0,013
2.	Raw	30	21	29,0	1,4	10,07	11,54	116,2	0,012
3.	Raw	30	21	28,5	2,0	9,97	10,83	108,0	0,019
Average									0,015
4.	1,5%	30	21	29,5	0,7	11,22	10,91	122,4	0,006
5.	1,5%	30	21	28,8	1,6	10,03	10,20	102,3	0,016
6.	1,5%	30	21	28,9	1,5	11,06	10,47	115,8	0,013
Average									0,012
7.	2,5%	30	21	29,0	1,4	10,67	11,11	118,5	0,012
8.	2,5%	30	21	28,2	2,4	10,66	11,78	125,6	0,019
9.	2,5%	30	21	29,2	1,1	11,06	11,78	115,8	0,010
Average									0,014
10.	3,5%	30	21	28,5	2,0	10,76	10,21	109,9	0,019
11.	3,5%	30	21	29,0	1,4	11,24	10,38	116,7	0,012
12.	3,5%	30	21	28,5	2,0	10,71	10,61	113,6	0,018
Average									0,016

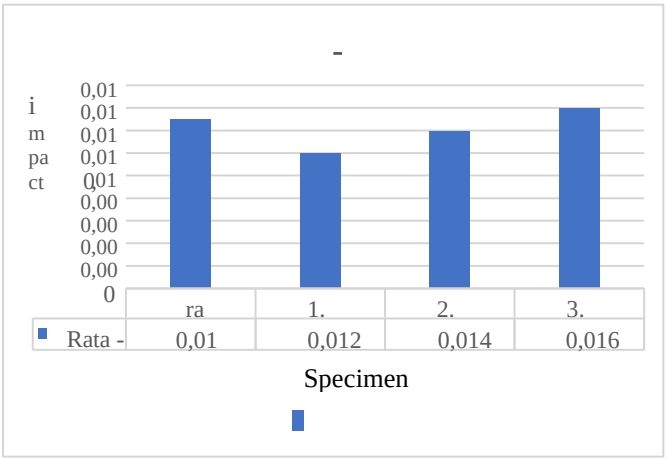

Figure 3. Average Impact Test Results

The impact test results on sugar cane fiber composite specimens using the ASTM E23 standard and the Universal Testing Machine brand impact testing machine using the Charpy method can be seen in the impact test results in table 2 which shows the results of 12 specimens, consisting of 3 specimens each. – each variation, including raw material, 1.5% sugarcane fiber, 2.5% sugarcane fiber, 3.5% sugarcane fiber.

Data analysis of sugar cane fiber composites on impact strength. Fig 3, shows that the polyester resin matrix composite with 1.5%, 2.5% and 3.5% sugar cane fiber reinforcement material produces the largest average stress data in the 3.5% fraction of 0.016 J/$mm2$, while fraction 1, 5% is the lowest yield of 0.012 J/$mm2$. Based on the value of the impact test results with sugar cane fiber reinforcing material, the specimen that has the greatest impact strength that can be used in making motorbike fairings can be taken at a fraction of 3.5%.

IV. CONCLUSIONS

1. From the tensile test results, it can be concluded that the three volume fractions with added sugar cane fiber have the maximum tensile strength of the raw material (without added fiber) with an average value of tensile strength of 30.1 Mpa. So the addition of sugar cane fiber does not affect the tensile strength because it reduces the tensile strength with each addition of sugar cane fiber.

2. From the results of the bending tests, it can be concluded that the three additions of sugarcane stem fiber have different maximum bending strengths for each variation of the addition of sugarcane stem fiber, the highest maximum bending strength for the addition of sugarcane stem fiber is 1.5% with an average bending strength amounting to 27.09 Mpa. The addition of sugar cane fiber affects bending strength.

3. From the results of the impact test, it can be concluded that the three fractions of sugarcane stem fiber addition have different maximum impact values for each variation, the highest maximum impact strength is 3.5% fiber addition with an average impact strength of 0.016 J/$mm2$. The addition of sugar cane fiber affects the impact strength.

REFERENCES

[1] Aksar, Prinob, Abd. Kadir, and ridway balaka. 2022. "Tensile strength analysis of sugarcane fiber reinforced polyester resin polymer composite materials." Dynamics: scientific journal of mechanical engineering 13(2): 82.

[2] Andriansyah, Tomi, and Fadli Kurnia. 2023. "The influence of sugarcane fiber on mechanical properties." Artesian Journal 3(1): 117–22.

[3] Garabha, ahimsa. 2022. "This nanofiber mask made by UNY students is made from sugarcane bagasse waste."

[4] Margono, bambang, haikal haikal, and lujeng widodo. 2020. "Mechanical properties analysis of HDPE plastic composite material reinforced with bagasse fiber in terms of tensile and bending strength." Ame (applications of mechanics and energy): scientific journal of mechanical engineering 6(2): 55.

[5] Rahmawaty, Siti Auliana. 2021. "Analysis of tensile and bending strength in fiberglass-polyester composites reinforced with glass fiber with variations in fiber

volume fraction." Jtm-iti (iti mechanical engineering journal) 5(3): 146.

[6] Ramadhani, Muhammad Zainur. 2019. "The influence of the composition of natural fiber matrix composites (coconut and sugar cane) on tensile and impact strength." 7: 41–50.

[7] Rifaldi, Ahmad. 2022. "Strength characteristics of sugarcane fiber as a composite reinforcement with Yukalac 157 bqtn-ex polyester matrix in tensile and bending tests." Thesis.

[8] Rusnoto. 2020. "Utilization of sugarcane tree powder in materials." Mechanical Engineering Study Program, Faculty of Engineering, Pancasakti University, Tegal, 1(1): 8–14.

[9] William D callister Jr, 1991, Material Science and Engineering, John Wiley, New York.