Hybrid Effect of Polyester Composite Reinforced Palm Powder and Coconut Coir Fiber

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Abstract- ***Palm fiber powder and coconut fiber are two materials that come from the waste from processing coconuts and palm fiber. The potential of these two materials can be utilized for the manufacture of composites using polyester resin. Because of the advantages of these two materials, a study was conducted to obtain the effect of hybrid polyester composites reinforced with fibers and coconut fiber in terms of tensile strength and composite impact values. Composites were made using the hand lay-up method for each volume fraction variation, palm fiber and coconut fiber 10%:10%; 10%:20%; 10%:30%; 20%:10%, 20%:20%; 20%:30% 30%:10%, and 30%:20%. Then, mechanical testing was carried out with the ASTM D638 I standard tensile test, and the ASTM D6110 standard impact test. Based on the results of tensile and impact tests, data analysis was carried out to produce a optimum impact strength dan tensile strength on the composition of the volume fraction mixture of 30% SSK and 10% SI, positive hybrid effect for longitudinal tensile stress and impact strength on the composition of the volume fraction mixture of 10% SSK and 30% SI, 20% SSK and 20% SI and 30% SSK and 10% SI.***

Indexed Terms- Polyester, Palm fiber, Coconut Coir Fiber, Hybrid Effect.

I. INTRODUCTION

Previous research on the polymeric composite matrix with coconut fiber reinforcement has been carried out where the addition of coconut fiber and coconut stem sawdust increases the mechanical properties of the composite material. (Romels et al., 2011), Then in 2018 Andre et al. investigated the effect of adding palm fiber particles to the composite, which, the proportion of weight and size affect the mechanical properties of the composite. In 2019, Romels, et al. investigated the flexural strength of coconut coir fiber composites where variations in volume fraction affect the flexural strength of composites. Then in 2021 Romels, et al investigated the effect of volume fraction and particle size of palm fiber that affects the mechanical properties and water absorption of polyester composites.

The researcher raised the topic of polyester composites reinforced coconut coir fiber and palm fiber powder based on the amount of coconut fiber waste and the availability of palm fiber as a basic material which is expected to be produced into composite materials.

II. RESEARCH GOALS

The purpose of this study was to obtain the effect of volume fraction on tensile strength and impact and the effect of hybrid composites of coconut fiber and palm fiber powder on the tensile strength and impact of composites.

III. LITERATURE REVIEW

- Tensile Strength

The linear relationship between the stress-strain for a member undergoing tension or compression so that the modulus of elasticity of the material is obtained is expressed as:

$\sigma = E \cdot \varepsilon$ ……(1)

where the relationship between tensile load and stress is

$\sigma = \frac{P}{A}$ ……(2)

with P = Tensile load (N)

A = Cross-sectional area (mm^2)

σ = Stress (MPa)

Furthermore, strain is an inverse relationship between the increase in length and the initial length

$\varepsilon = \frac{\Delta l}{l_0}$ ……(3)

where:

ε = strain (mm/mm)

ΔL = length increase (mm)

lo = *gage length*, mm

The value of the modulus of elasticity of the composite which is also the ratio between stress and strain in the proportional area can be calculated by the equation (Surdia, 1995)

$$E = \frac{\sigma}{\varepsilon} \quad \text{.....(4)}$$

where:

E = Modulus of tensile elasticity MPa)

σ = Tensile strength (MPa)

ε = Strain (mm/mm)

In macromechanics, the longitudinal tensile strength of the hybrid composite is determined by the equation (Hashemi dkk., 1997):

$$\sigma_{1HC} = \frac{P}{A_{HC}} \text{.....(5)}$$

According to mixed rules (Hashemi dkk, 1997), The longitudinal tensile strength of the hybrid composite can be determined by Equivalent :

$$\sigma_{1HC} = \sigma_{1mA} \cdot \chi_{fA} + \sigma_{1mB} \cdot \chi_{fB} \text{.....(6)}$$

where :

σ_{1fA} = longitudinal tensile strength of composites with A reinforcing fibers.

σ_{1fB} = longitudinal tensile strength of composites with B reinforcing fibers.

x_{fA} = single fiber hybrid ratio A.

x_{fB} = single fiber hybrid ratio B.

- *Impact Strength*

Impact strength analysis was performed using the Charpy impact test. The magnitude of the impact strength on the macro-mechanical composite can be determined by the equation:

$$a_{CN} = \frac{W}{hxb_N} \quad \text{.....(7)}$$

where W is the energy absorbed at the fracture of the specimen with a thickness h and width to the bottom of the notch b_N.

In hybrid composites, the impact strength can also be determined according to the mixture rules (Hashemi dkk, 1997) that base on *rule of hybrid mixture* (Hasemi dk,1997) i.e.:

$$a_{Hau} = a_{CfA} \cdot \chi_{fA} + a_{CfB} \cdot \chi_{fB} \quad \text{...(8)}$$

Where :

a_{CfA} = impact strength of composite with A. reinforcing fiber

x_{fA} = single fiber hybrid ratio A

a_{CfB} = impact strength of composite with B reinforcing fiber

x_{fB} = single fiber hybrid ratio A

Impact testing is a response to shock loads or sudden loads (impact load) (calliester, 2017).

W = mg.R.(cos β - cos α) .....(9)

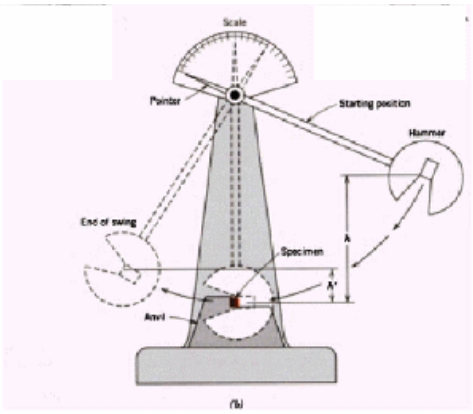

Figure 1 Impact Test Mechanism

where:

W : absorption energy (J)

m : pendulum weight (kg)

g : acceleration due to gravity (m/s^2)

R : sleeve length (m)

α : pendulum angle before swinging

β : pendulum swing angle after breaking the specimen

Impact Price can be calculated by :

$$a_{CN} = \frac{W}{Ao} = \frac{W}{hxb_N} \text{.....(10)}$$

Where :

a : Impact Price(J/mm2)

W : Absorption energy (J)

Ao : Cross-sectional area (mm^2).

IV. RESEARCH METHODOLOGY

The research procedure carried out according to the following stages. Stage 1. Sample preparation. Stage 2. Producing Sample testing following ASTM D638 I standard tensile test, and the ASTM D6110 standard impact test. Stage 3. Preparation of test specimens. Stage 4. Specimen testing. Stage 5. Sample testing data analysis

V. DISCUSSION AND RECOMMENDATION

Tensile testing was carried out on composites made from fiber and palm fiber powder which were treated with 5% NaOH alkali for the volume fraction of SSK and SI. 10%:10%; 10%:20%; 10%:30%; 20%:10%,; 20%:20%; 20%:30% 30%:10% and 30%:20%.

Table 1 Average Tensile Strength

Fraksi Volum	ε (%)	σ (N/mm2)	E (N/mm2)
10:10	6,842	64,103	9,459
10:20	8,684	78,125	9,018
10:30	9,006	82,532	9,197
20:10	9,094	87,740	9,649
20: 20	9,123	92,548	10,155
20:30	9,386	96,154	10,248
30:10	9,503	96,554	10,168
30:20	9,474	96,154	10,155

In table 5 there is an average value of absorption energy and impact value for each volume fraction

Table 2 Average Impact Resilience

Fraksi Volum	Esrp (J) rata-rata	HI (J/mm^2) rata-rata
10:10	1,291	0,033
10:20	1,609	0,041
10:30	2,679	0,068
20:10	3,171	0,080
20: 20	3,224	0,082
20:30	3,274	0,083
30:10	3,528	0,090
30:20	3,377	0,086

VI. DISCUSSION

Based on the results of the analysis of the tensile and impact strength test data for each volume fraction variation, the relationship between the volume fraction variation and the tensile strength and impact strength is obtained, namely the absorption energy and the impact value. The maximum value for both tensile and impact strength values is in the volume fraction of 30% SSK and 10% SI.

The results of each data processing are used to obtain the effect of hybrids on composites reinforced with coconut fiber and palm fiber powder. Through the discussion, it produces a hybrid effect both on tensile strength and impact strength, which has a positive effect on the composition of the volume fraction mixture of 10% SSK and 30% SI, 20% SSK and 20% SI and 30% SSK and 10% SI.

CONCLUSION

- The maximum value for both tensile and impact strength values is in the volume fraction of 30% SSK and 10% SI.
- The hybrid effect for longitudinal tensile stress and impact strength is positive for the volume fraction mixture composition of 10% SSK and 30% SI, 20% SSK and 20% SI and 30% SSK and 10% SI.

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