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Analysis Impact Test Composite Sawdust Meranti And Tilapia Scales With Resin Polyester

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Abstract

This research aims to analyze the impact toughness of polyester resin-based composite materials reinforced with meranti wood sawdust and tilapia fish scales as natural fillers. The utilization of biomass waste such as wood dust and fish scales in composite development contributes not only to waste reduction but also offers environmentally friendly material alternatives with promising mechanical performance. The study employs an experimental method using four volume fraction variations: 100% resin, 60% resin–25% wood dust–15% fish scales, 70% resin–20% wood dust–10% fish scales, and 80% resin–15% wood dust–5% fish scales. Specimens were fabricated using the hand lay-up technique and tested for impact resistance using the ASTM D6110 Charpy standard.The results show that the variation in filler volume fractions significantly affects the impact toughness of the composite. The best performance was observed in the 60% resin, 25% wood dust, and 15% fish scales composition, with an absorbed energy of 4.31 joules and an impact value of 16576.92 J/m². In contrast, the 100% resin composition, which contained no filler, recorded the lowest absorbed energy of 1.04 joules and an impact value of 4000 J/m², highlighting the significant role of filler in enhancing impact resistance. The fracture surfaces of the specimens indicated that greater and more evenly distributed filler content led to stronger bonding and more cohesive break patterns. These findings demonstrate that meranti wood sawdust and tilapia fish scales waste have strong potential as reinforcing agents in eco-friendly polyester resin-based composites. Furthermore, the study supports the development of sustainable materials by utilizing abundant industrial wood and fishery waste commonly found in Indonesia. Thus, the use of meranti wood powder and tilapia fish scales as fillers in polyester resin composites demonstrates a positive effect on material toughness and shows promise as an eco-friendly material alternative..

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Keywords: Meranti wood powder, tilapia fish scales, polyester resin, composite impact test

INTRODUCTION

Composite materials are a major focus in modern material development because they combine the superior properties of their constituent components, namely the matrix and the reinforcement. The matrix acts as a binder, while the reinforcement provides strength and stiffness. (A. Hidayat et al., 2016). .The use of natural materials such as biomass waste is now increasingly in demand due to its abundant availability, low cost, and environmental friendliness. (Gunandar, 2021a).

Fish scales, especially from tilapia, have potential as a composite reinforcing material. (Mahyudi et al., 2024 ; Ruzek et al., 2019) . From tilapia cultivation, 1–2% or around 14.4 kg/year of scale waste is obtained which has not been optimally utilized. (Nurhidayat, 2021). In addition, fish scales can also be processed into chitosan, with a good degree of deacetylation for material applications. (SIMAMORA, 2023 ; Sabido et al., 2020).

Meranti sawdust waste is also a potential material, with an average production of 5 kg/day by wood craftsmen, but has not been utilized optimally. (RD Handoko & Setiawan, 2022). This combination of sawdust and fish scale waste has the potential to be used as a reinforcing material in a polyester resin matrix, a type of thermoset resin that is widely used and produces a rigid composite after the drying process. (Gunandar, 2021b ; Arta et al., 2020 ; Ariviadi, 2021).

This study aims to analyze the impact test of composites made from meranti wood powder and tilapia fish scales with polyester resin. (Aundry & Munang, 2024 ; Riadi, 2019). It is hoped that the resulting composite will not only be environmentally friendly but also have good impact resistance, as well as contribute to the management of waste from the wood and fisheries industries (Dinata et al., 2023 ; Wulandari et al., 2024 ; Yousaf et al., 2021).

METHODOLOGY

This study used an experimental method. Four variations of volume fraction were tested using the Charpy impact test method (Lumintang et al., 2011) . Specimens were made using the hand lay-up technique (Aljabar, 2021 ; Godara et al., 2022). The main ingredients are polyester resin, meranti wood powder, and tilapia scales. The specimens were manufactured according to ASTM D6110 standards. (Wahyudi, 2021). Impact testing was conducted at the New and Renewable Energy Laboratory of the Kalimantan Institute of Technology (Laksono et al., 2024). The volume fraction composition of each specimen is (Hermawan et al., 2020) :

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Table 1. Composite Volume Fraction

Sampel	Resin polyester V_{Rc} (%)	Serbuk kayu meranti V_{Sg} (%)	Sisik ikan nila V_{Sn} (%)
1	100	0	0
2	60	25	15
3	70	20	10
4	80	15	5

RESEARCH RESULTS AND DISCUSSION

Adsorbed energy calculations

1. Specimen 1 100% resin, 0% mandarinwood powder, 0% goldfish scales
   W = G x λ x (cos β – cos α) (joules)
   W = 16 kg x 0.5 mx 9.8 m/s ^{2} x (cos 129 – cos 130)
   W = 1.04 Joule
2. Specimen 2 60% resin, 25% mandarinwood powder, 15% goldfish scales
   W = G x λ x (cos β – cos α) (joules)
   W = 16 kg x 0.5 Mx 9.8 m/s ^{2} x (Cos 126 – Cos 130)
   W = 4.31 Joule
3. Specimen 3 70% resin, 20% mandarinwood powder, 10% goldfish scales
   W = G x λ x (cos β – cos α) (joules)
   W = 16 kg x 0.5 mx 9.8 m/s ^{2} x (cos 127 – cos 130)
   W = 3.21 Joule
4. Specimen 4 80% resin, 25% meranti wood powder, 5% tilapia fish scales
   W = G x λ x (cos β – cos α) (joules)
   W = 16 kg x 0.5 mx 9.8 m/s ^{2} x (cos 128 – cos 130)
   W = 2.12 joules

Impact price calculation

1. Specimen 1 100% resin, 0% meranti wood powder, 0% tilapia fish scales.
   HI = ^{W} (Joule/m $^{2)}$
   A
   HI = *1.04 joules*
   0.00026 2

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HI = 4000 joules/m ^{2}

2. Specimen 2 60% resin, 25% sawdust, 15% tilapia scales

HI = ^{W} (Joule/m $^{2)}$

A

HI = *4.31 joules*

0.00026m2

HI = 16576.92 joules/m ^{2}

3. Specimen 3 70% resin, 20% meranti wood powder, 10% tilapia fish scales

HI = ^{W} (Joule/m $^{2)}$

A

HI = *3.21 joules*

0.0002 2

HI = 12346.15 joules/m ^{2}

4. Specimen 4 80% resin, 15% meranti wood powder, 5% tilapia fish scales

HI = ^{W} (Joule/m $^{2)}$

A

HI = *2.12 joules*

0.00026m2

HI = 8153.84 joules/m ^{2}

From the observation of the fracture cross section of the composite, the fracture that occurred was generally brittle. The best fracture was obtained in the specimen with a volume fraction of 60%:25%:15% (Ali & Syahrir, 2024) . This is because the volume fraction of 60%:25%:15% contains a lot of filler and is evenly distributed on the fracture surface, so that the binding power of the filler to the matrix can be perfectly integrated (Rangga et al., 2023 ; D. Handoko et al., 2022 ; Yudhyadi & Sari, 2013 ; Napitupulu et al., 2018) .



(a) (b)

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Figure 1. Specimen before testing (a) and after testing (b)

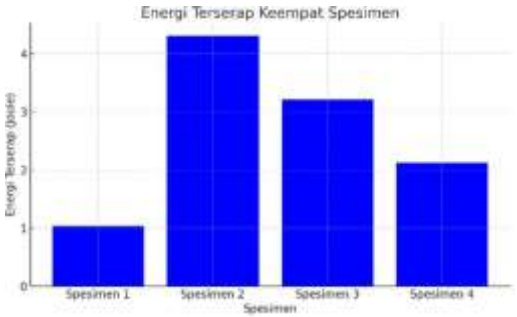


Figure 2. Graph of absorbed energy data

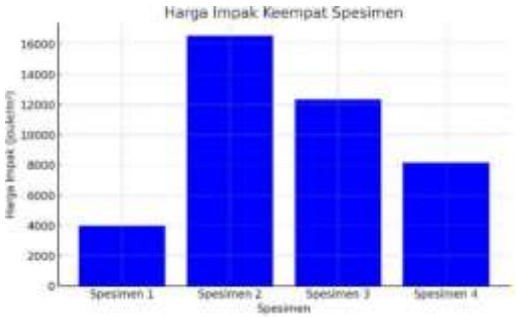


Figure 3. Impact price data graph

Impact test results show an increase in toughness with increasing filler content. The volume fraction of 60%:25%:15% showed the highest impact value of 16576.92 J/m². The even distribution of filler resulted in a more stable fracture cross-section, demonstrating better bonding between materials (S. Hidayat, 2019 ; NURGIANSYAH, 2025 ; Yani & Haripriadi, 2022).

CONCLUSION

Based on the research results, analysis results and discussions that have been presented by the author, the following conclusions can be drawn from the overall analysis results:

a. The highest impact strength of meranti wood powder composite with polyester resin is at a volume fraction of 60%:25%:15% with an impact value of 16576.92 J/m², while the lowest impact strength is at a volume fraction of 100%:0%:0% with an impact value of 4000 J/m².
b. The fracture cross section of the impact test composite shows brittle fracture.

SUGGESTION

Several suggestions need to be considered in impact testing and further research,

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including the following:

a. Before testing, the impact test tool should be calibrated first to obtain precise results and calculations.
b. In the process of making composite materials, it is recommended to use additional PPE to avoid chemical side effects.
c. Further research is recommended to conduct trials to apply this composite mixture so that it can be applied to a product.
d. Further research is recommended to be able to conduct microscopic observations of the shape or type of fracture resulting from composite testing.

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