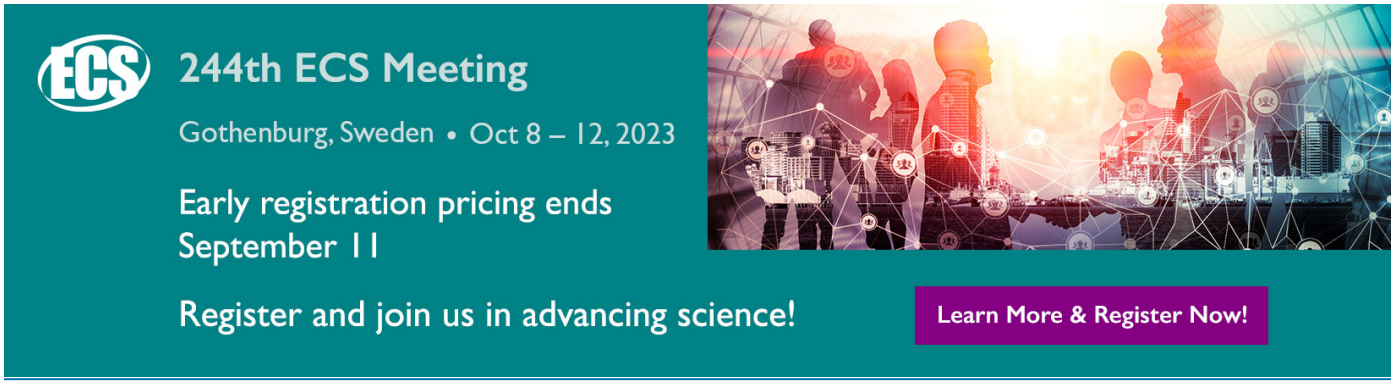
Bamboo Composite Compressive Strength With Three Layer Configuration



Bamboo Composite Compressive Strength With Three Layer Configuration

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Abstract.
The use of composite materials in the automotive industry aims to create new material that have advantage of good mechanical properties, environmentally friendly and cheaper. Composite is a combination of two or more materials that have good physical properties and good mechanical properties. Reinforcement materials commonly used in polymer composites are natural bamboo strips can be used as reinforcement materials and matrix used was epoxy resin polymer. The research phase began with the manual cutting of bamboo into bamboo strips using a knife with a thickness of 0.5-0.8 mm and width of 4.0-6.0 mm bamboo strips. Bamboo strips were given 5% alkaline treatment for 72 hours, after alkaline treatment is complete the bamboo strips are washed with clean water flow and dried at room temperature for 48 hours. Reinforcement that is used is plain weave type using bamboo strips. The composite manufacturing process uses the hand lay-up method. The configurations of orientation angle that is used are 0°/0°/0°; 0°/45°/0°; 0°/90°/0°. Compressive test with ASTM D3410/D3410M-16 and observe microstructure using SEM (Scanning Electron Microscope). Composite with configurations of orientation angle of 0°/0°/0° have the highest average impact value of 0.216 J/mm^2 and an average compressive strenght of 69.740 MPa with average modulus of elasticity of 41.660 GPa. The result of observe using SEM (Scanning Electron Microscope) are given initial signs of specimen damage, delaminate and buckling.

1. Introduction

In the automotive industry, technology in the material field is developing rapidly, this has caused companies in the automotive sector to continue to create creativity and innovation to create the latest technological breakthroughs that are better and more environmentally friendly [1].At this time there are still many materials in the automotive sector that use layers of material that are less environmentally friendly and difficult to recycle both during the production process and when it becomes waste [2,3]. From this matter the selection of materials in the automotive field must have alternatives with environmentally friendly materials, have low prices and have plenty of resources without reducing the strength, toughness and rigidity in order to maximize these functions. [4,5].Apus bamboo has quite good mechanical properties, it needs to be made into a composite as an alternative material[6]. Composite materials are engineering materials made from a combination of two or more materials to produce a unique combination of properties [7]. Composite itself is a combination of matrix or binder material with reinforcement [8].One of the easy composites is bamboo composite with three layers configuration [9]. This three-layer configuration includes bamboo glued together with resin and arranged into three layers. Compressive testing to determine the characteristics of the three layers layer of apus bamboo.It is expected that the results of this test can find out the characteristics of the three-layer configuration bamboo composite so that in the future the three-layer configuration apus bamboo can replace materials in the automotive industry.

2. Materials and Method

Bamboo is taken from the village of Parung Panjang, Bogor City, which is a type of apus bamboo (gigantochloa apus) aged 3-4 years and then cut with a knife manually to strip size with a thickness of 0.7 - 1.0 mm and 5.0-8.0 mm wide. Raw materials in the form of bamboo strips are woven using plain weave weaving techniques [10] with dimensions of 300 x 300 x 1 mm. Composite manufacturing process is carried out by hand lay-up method. Composites that have been manufactured are cut using laser cutting, the dimensions are in accordance with the compressive testing standards. ASTM D3140/ D3140M – 16 [11].

3. Result and discussion

From the research stages, the results of the tests are as follows:

Figure 1. Compressive Test Results on Specimen A

Figure 2. Compressive Test Results on Specimen B

Figure 3. Compressive Test Results on Specimen C

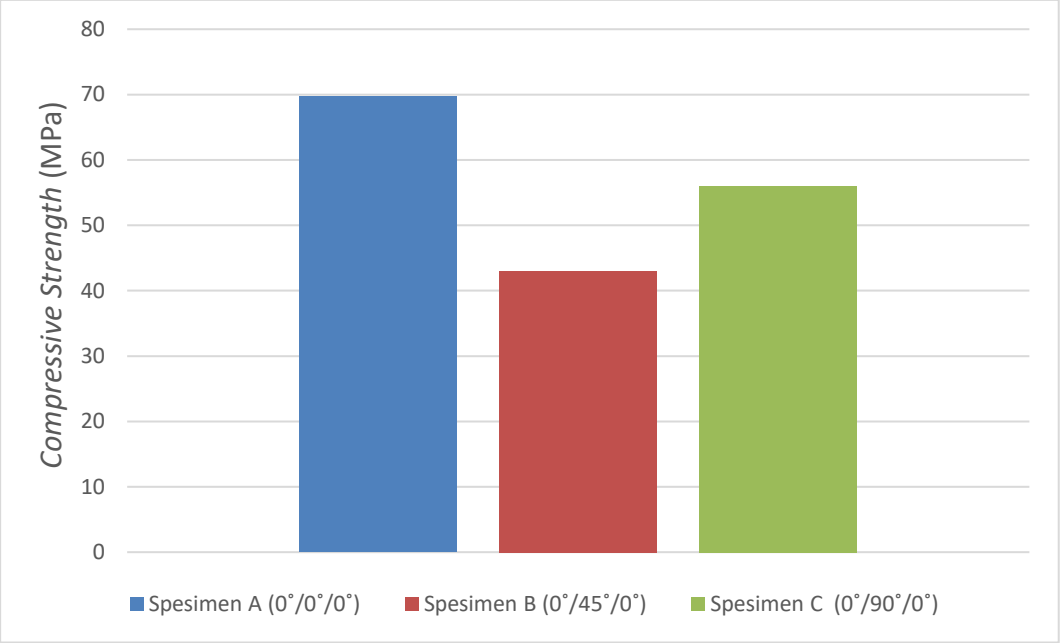

Figure 4. Graph of Average Compressive Strength

From the results of compressive testing in figure 4, specimen A with an orientation angle configuration of 0°/0°/0° has the highest average compressive strength with a value of 69.740 MPa. Specimen C with an orientation angle configuration of 0°/90°/0° which has an average compressive strength of 56.010 MPa and specimen B with an orientation angle configuration of 0°/45°/0° has an average compressive strength of 43.000 MPa. This is due to specimen A having a uni-directional bamboo strip arrangement so that it shows cross-linking between laminates that is continuous compared to specimen B and specimen C with laminate arranged on bamboo strips that are not unidirectional and have cross links which is not continuous.

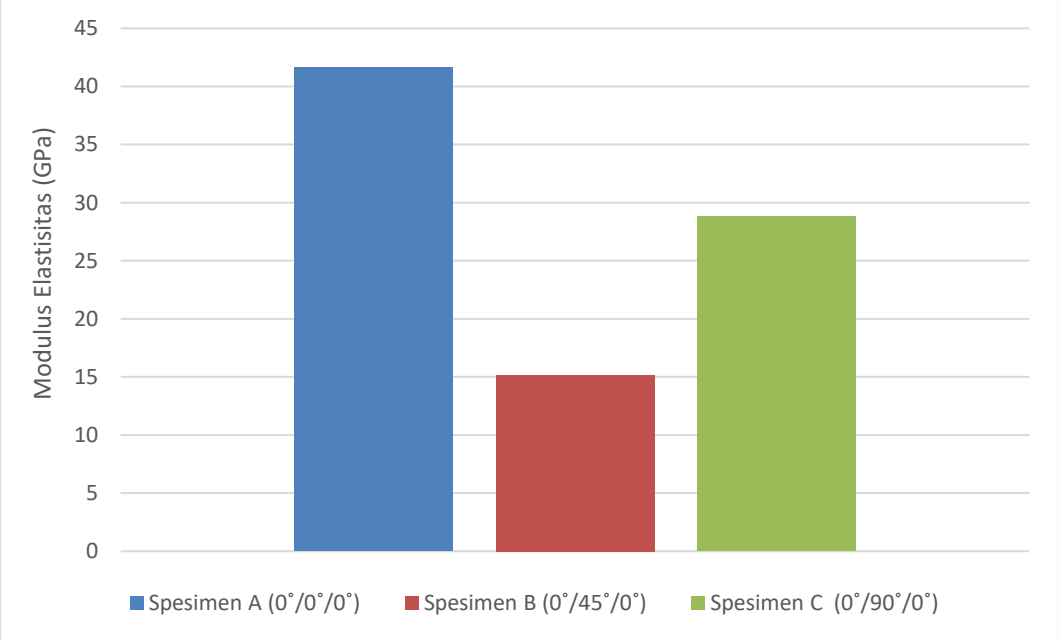

Figure 5. Graph of Average Value of Modulus of Elasticity

The results of compressive testing of the average modulus of elasticity in figure 5, specimen A with an orientation angle configuration of 0 ° / 0 ° / 0 ° which has the largest average modulus of elasticity with a value of 41.660 GPa, followed by specimen C with an orientation angle configuration of 0°/90°/0° which has an average modulus of elasticity of 28.820 GPa and specimen B with an orientation angle configuration of 0°/45°/0° which has an average modulus of elasticity of 15.140 GPa.The value of the greater elastic modulus indicates that the specimen is getting stiffer. This shows that composites with laminates arranged in a uni-directional direction have more rigid properties compared to laminate composites that are not unidirectional. This stiffness indicates that the specimen is able to withstand high loads but will be more brittle because the elastic limit that is owned is lower / smaller than specimens that are more elastic.

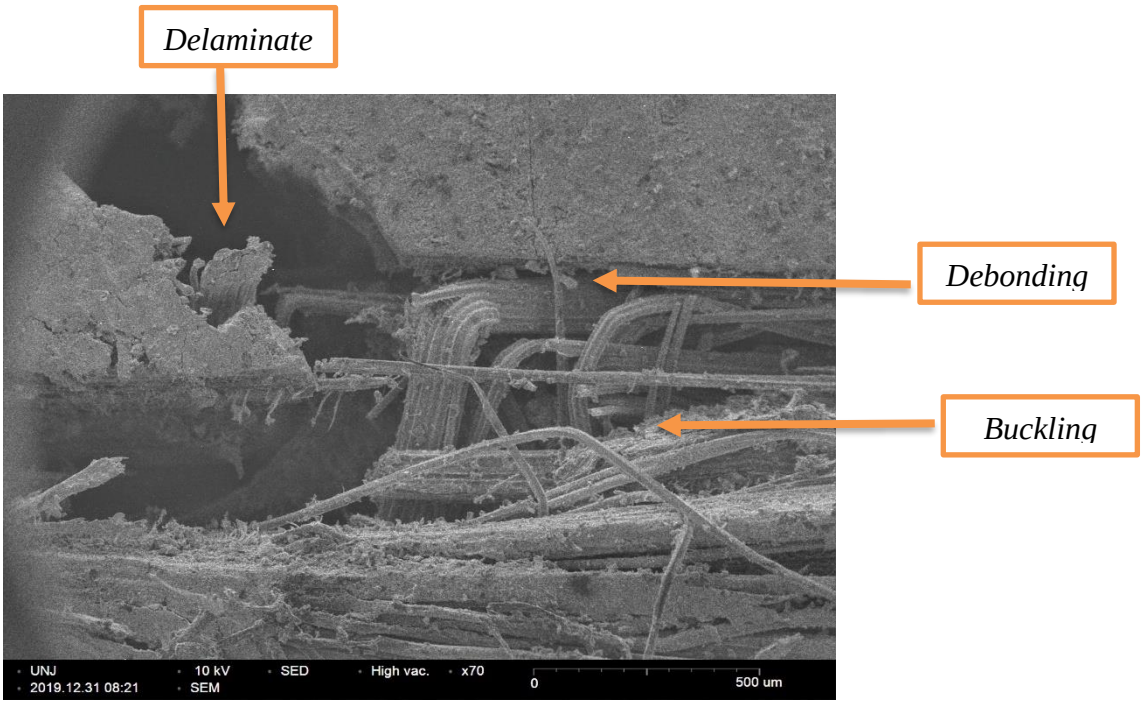

Figure 6. Result of observations with Scanning Electron Microscope

In the figure 6, the shape of the fracture of the specimen after testing shows debonding occurred which caused the specimen to be damaged. Debonding is an event or mechanism for releasing interfaces between composites [12]. Delaminate is one of the critical damage models that occur in laminate composites. Delamination occurs due to several factors such as high interlaminar stress and stress concentrations at the crack location or other damage to the laminate.Buckling can also be called a process where a structure is not able to maintain the original shape. Buckling is a basic geometric problem, where a large deflection occurs so that it will change the shape of the structure [13].

4. Conclusion

1. Specimens with an orientation angle configuration of 0°/0°/0° have a higher compressive strength of 69,740 MPa, than a specimen with an orientation angle configuration of 0°/45°/0° and 0°/90°/ 0°.
2. Specimens with 0°/0°/ 0° orientation angle configuration have the smallest compressive strain value from the test results that is equal to 0.002 mm / mm.
3. The results of observations with SEM (Scanning Electro Microscope) on the results of the three-layer bamboo composite test, it can be seen that there was debonding, delaminate, and buckling on the three-layer bamboo composite material.

5. References

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