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Tensile Properties of Bamboo Strip Reinforced-Epoxy Matrix Composite

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Abstract. Composite is a combination of two or more materials, where one type materials is mixed into another type of materials. Combining several different phases will create a material with performance better than the earlier phase of the constituent. In this study, a composite consisting of a polymer matrix by using a type of epoxy thermosets, reinforced using natural bamboo. The bamboo species used in these tests were Gigantoacloa Apus, age 3 – 4 years, collected from Bogor Indonesia. The bamboo were cut into lumber strip fiber parts using a cleaver and hand saw. The strip was cut by knife to thicknesses of 0.6 mm – 0.8 mm and width 1.5 mm – 1.8 mm. The types of bamboo weave are plain weave, with laminate size 300 mm x 300 mm x 1 mm. The manufacture process was by hand lay-up end cut with a laser, according to ASTM D 3039-08 standards. Where each sample taken five specimens, furthermore, the tension test process. The yield stress on the specimen has a value of 11.05 ± 0.55 MPa. The result of the maximum tensile stress on the specimen without alkali treatment has a value of 15.43 ± 1.14 MPa. Keywords: composite, bamboo, orientation angle, tensile strength.

1. Introduction

Since two decades natural fibre composites are emerging as realistic alternatives to replace the glass reinforced composites in many application [1], [2]. Natural fibers such as banana, sisal, jute and bamboo have attracted the attention of scientists and technologists for application in consumer goods, low cost, and other civil structures [3]. Natural fiber has many advantages compared to synthetic fiber like low density, cheaper, acceptable specific properties and also they are renewable and biodegradable [3], [4], [5]. These composites have high strength and stiffness, good thermal and acoustic insulating properties and high resistance to fracture [6], [7]. Bamboo is fast being explored as wood substitute and one of the main reason for this is that it can be harvested in 3 – 4 years from the time of plantation as opposed to timber, which takes decades [8]. Bamboo as sustainable resource, abundantly available and bio gradable, is widely used in producing bamboo based composites such as bamboo plywood, laminated bamboo lumber, bamboo scrambler, bamboo particle board and bamboo reinforcing polymer composite [9]. The cylindrical shape of the bamboo culm is, however, a limitation for its direct use in several engineering systems [10]. Bamboo fibre can be used for variety of



structural and some structural applications due to its good specific properties, renewability and other environmental benefits [11].

2. Materials and Methods

The bamboo species used in these tests were *Gigantocloa Apus*, age 3 – 4 years, collected from Bogor Indonesia. The bamboo were cut into lumber strip fiber parts using a cleaver and hand saw. The type of polymer used for resin is epoxy. The strip was cut by knife to thickness of 0.6 mm – 0.8 mm and width 1.5 mm – 2 mm. Types of bamboo woven plain weave, with size 300 mm x 300 mm x 1 mm. Process manufacture hand lay-up, is a method of manufacturing a composite material by hand with the help of a brush or roller in the application of the matrix (resin) and hardener (catalyst). Reinforcement layer laid on the mold and poured polymer. In general, the stage of making a composite material products with this is by applying matrix (resin). Making specimens, cut with a laser, according to ASTM D3039/D3039M-08 standards [12], [13].

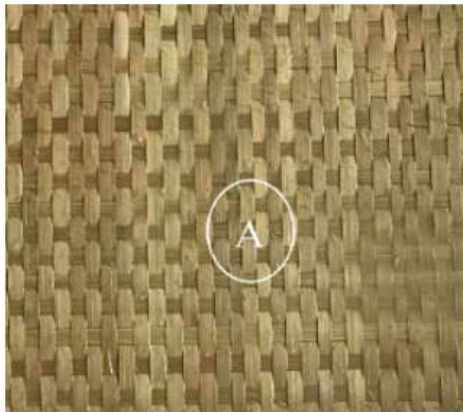


Figure 1. Plain weave

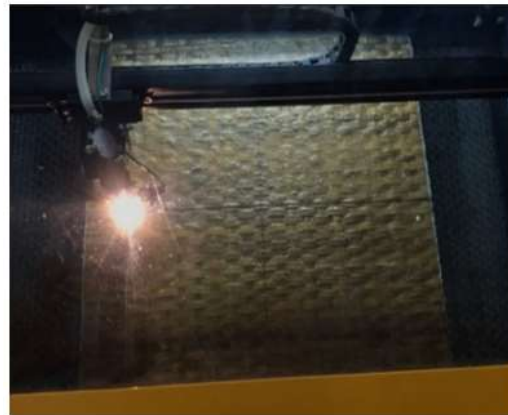


Figure 2. Laser cutting specimen

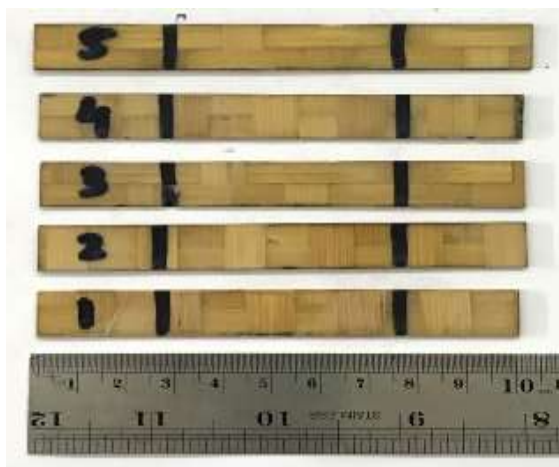


Figure 3. Specimens tension test



Figure 4. Tension test

3. Results and discussion



Figure 5. Tensile test results specimen

Table 1. Data of yield tensile of tension testing results

Specimen	t (mm)	l (mm)	Ao (mm ²)	F _y (N)	ε (%)
1	1.80	13.20	23.80	243.00	4
2	1.60	13.30	21.30	268.00	9
3	1.80	13.40	24.20	262.60	8
4	1.70	13.40	22.80	253.00	12
5	1.70	13.50	22.90	260.40	16

Table 2. Yield strength of tension testing results

Specimen	F _y (N)	Ao (mm ²)	σ _y (MPa)
1	243.00	23.80	10.21
2	248.00	21.30	11.65
3	262.60	24.20	10.85
4	253.00	22.80	11.10
5	260.40	22.90	11.40
		σ _{y rata} ²	11.05
		σ _{y min}	10.21
		σ _{y max}	11.40
		St dev	0.55

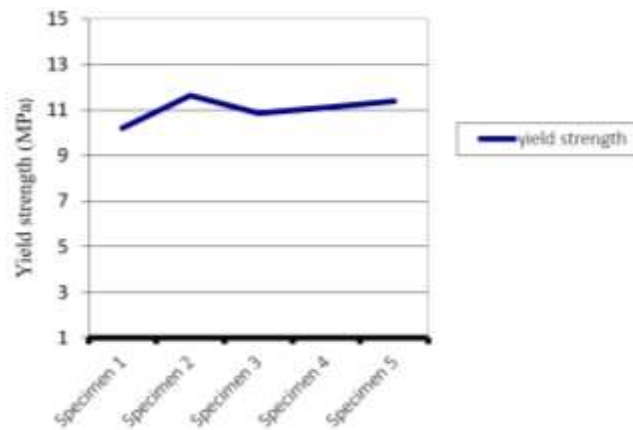


Figure 6. Yield strength for 5 specimens from tensile testing

Table 3. Data of tensile testing results

Specimen	t (mm)	l (mm)	ε (%)	F_u (N)
1	1.80	13.20	4	333.20
2	1.60	13.30	9	366.40
3	1.80	13.40	8	343.00
4	1.70	13.40	12	320.90
5	1.70	13.50	16	340.10

Table 4. Maximum tensile strength of tensile testing results

Specimen	F_u (N)	A_o (mm^2)	σ_u (MPa)
1	333.20	21.44	15.54
2	366.40	21.28	17.22
3	343.00	24.30	14.12
4	320.90	20.96	15.31
5	340.10	22.78	14.93
		$\sigma_{u \text{ rata}}^2$	15.43
		$\sigma_u \text{ min}$	14.12
		$\sigma_u \text{ max}$	17.22
		St dev	1.14

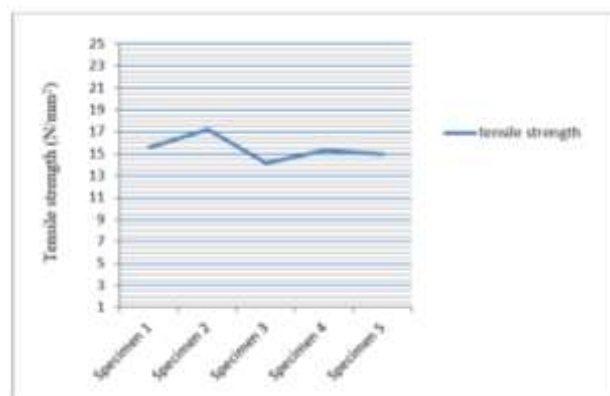


Figure 7. Tensile strength for 5 specimens from tensile testing

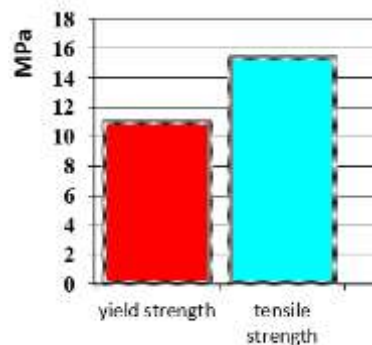


Figure 8. Comparison yield and tensile strength from tension testing

4. Conclusion

Based on the results of the research, the strength of bamboo composite as follows:

- The average tensile test result for plain weave composite with yield strength $\sigma_y = 11.05 \pm 0.55$ MPa
- the average tensile test result for plain weave composite with tensile strength $\sigma_u = 15.43 \pm 1.14$ MPa

The results obtained will be used as a reference in the development of bamboo fiber composites, especially in developing bamboo fiber composite products.

5. References

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