Green Material Characterization Of Recycled Fabric Waste Composite For Unmanned Aerial Vehicle (UAV) Structure

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Abstract. Currently, a significant amount of waste textiles are buried or burned, which has serious environmental consequence. C onsequently, recycling textile wastes into high-mechanical products using environmentally friendly methods is crucial matter. One alternative for clothing waste is to make the abundant patchwork waste into composite materials. Composite is a material made from several supporting materials with the intention of making reused materials according to needs. This study aims to develop the utilization of patchwork waste from a research perspective to make new materials more useful. This study aims to analyze the mechanical properties of composites made of cloth fibers and glass fibers. Specimens were made from fiber glass WR 600 and fabric fiber as a main material, with the resin and hardener as matrix. The composite was created using hand lay-up technique. The variation used in this test is the configuration layer between the fabric and the glass fiber. The testing method using ASTM D638-02 for tensile test and ASTM 790-02 for bending test were conducted. The result of this test is that in the tensile test, the highest average is obtained in the variation of the glass-cloth layer, or the layer with code D with a value of 113.305 MPa. In the bending test, the highest average value was obtained for the glass-fabric-glass coating variation, or with code B with a value of 229.995 MPa.

Keywords: composite, recycle, green, manufacture.

1 Introduction

The need for human clothing is getting higher every day with the existence of new styles in the world of fashion. Therefore, a new problem emerged as a result of the development of the clothing industry, namely fabric waste which was abundant and difficult to decipher[1][2][3] .

Due to its numerous advantageous qualities, including high tensile strength and ease of processing, cotton fiber is the natural fiber that is most frequently utilized in the

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textile industry. It is simple to create the properties of yarn by combining it with other fibers. most textiles made with cotton [4] [5].

To increase their qualities, composite materials mix two or more different chemical compositions or structural types.[6][7]. Commonly, composite materials are constructed from matrix as content and fiber as reinforcement [8]. Composite generally are combinations of materials (e.g., fiber and metal, fiber and ceramic, fiber and polymer or metal and metal) [9][10]. . Since composites have good mechanical characteristics, they are chosen for usage in UAVs. The strength of composite materials is demonstrated by a higher strength-to-mass ratio when the material has strong mechanical characteristics and is lightweight [11]. Ships, aircrafts, automobiles and UAVs are using composite as their main materials[12]. Materials have issues with costs and the environment. The cost of the drone frame's material is fairly significant. And in terms of environmental issues, these materials might contribute to environmental pollution when released into the environment because they are difficult to degrade there [13].

As a result, the author of this study will use green composite materials to create a drone frame out of glass fiber and fabric waste. In this study, the tensile and bending strength of a drone frame composed of waste material will be examined.

2 Experimental Details

2.1 Materials

The cotton fabric waste combined with glass fiber woven roving (WR) 600 were used as the main hybrid composite. As matrix epoxy and hardener were applied.

2.2 Manufacturing

Hand lay up techniques were applied on manufacturing the hybrid composites. Layer variations between Cotton Fabric (CF) and Glass fiber (GF) were carried out as follow

- GF-GF-CF-CF
- GF-CF-CF-GF
- CF-GF-CF-GF
- CF-GF-GF-CF

2.3 Specimen

Specimens were standardized according to ASTM D638-02 and ASTM D790-02. Each variation, 5 samples were prepared as Fig 1 and Fig 2.

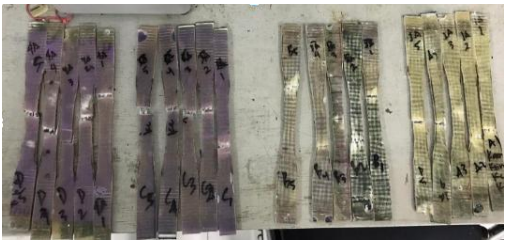

Fig. 1. Specimen prepared for tensile test.

Fig. 2. Specimen prepared for bending test.

3 Result and Discussion

Both mechanical tests were carried out using Universal Testing Machine (UTM) machine with capacity 30 ton UN-7001LC situated at Laboratorium of metallurgy, Adisutjipto Institute of Aerospace Technology.

3.1 Tensile Test

Table 1 shows the graph of the tensile test. Figure 3, is the visual presentation of the result.

Table 1. Tensile Test Result

Variation	Average (Mpa)	σ	Variant (%)
CF-CF-GF-GF	105.04	16.43	15.65
GF-CF-CF-GF	86.00	22.00	25.58
CF-GF-CF-GF	99.52	18.10	18.19
CF-GF-GF-CF	113.30	17.20	15.19

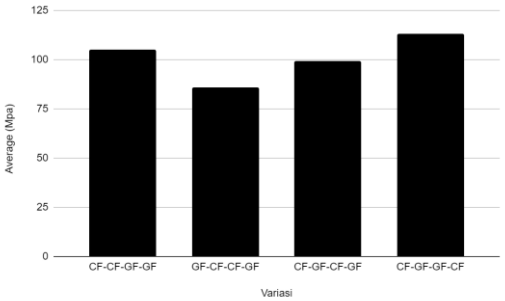

Fig. 3. Tensile Test Result.

Table 1 and Figure 3 showed that the highest tensile test was achieved by CF-GF-GF-CF variation at 113.30 MPa, followed by CF-CF-GF-GF, CF-GF-CF-GF, and GF-CF-CF-GF respectively at 105.04, 99.52, and 86.00 MPa. This is caused by the glass fiber acting as the core of this hybrid composite. As mechanical perspective base on Table 2, the GF is higher tensile strength compared with CF

Table 2. Properties of fibers and resins [14]

Description	Cotton fibre	Jute fibre	Glass multifilament yarn	Composite particles
Length (mm)	18 ± 2	50 ± 20	Continuous filament	0.65 ± 0.2
Diameter (μm)	11 ± 1	81 ± 13	16 ± 0.2	94 ± 14
Tensile strength (MPa)	167 ± 14	246.5 ± 33	654.4 ± 48	-
Modulus (GPa)	4.5 ± 0.5	22 ± 1.3	60.7 ± 0.4	-
Elongation (%)	5 ± 0.4	1.8 ± 0.4	3.5 ± 0.5	-

3.2 Bending Test

Table 3 shows the graph of the bending test. Figure 4, is the visual presentation of the result.

Table 3. Bending Test Result

Variation	Average (Mpa)	σ	Variant (%)
CF-CF-GF-GF	156.679	47.834	30.53
GF-CF-CF-GF	229.996	77.804	33.83
CF-GF-CF-GF	146.027	51.886	35.53
CF-GF-GF-CF	107.260	26.268	24.49

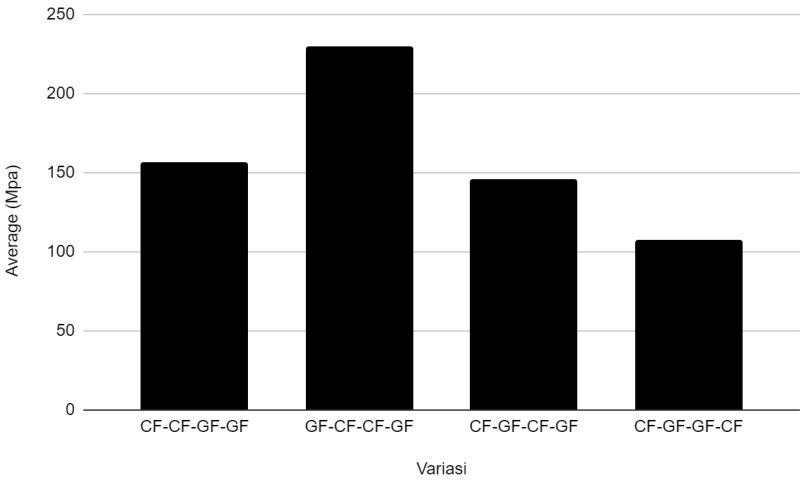

Fig. 4. BendingTest Result.

Table 3 and Figure 4 showed that the highest bending test was achieved by GF-CF-CF-GF variation at 229.996 MPa, followed by CF-CF-GF-GF, CF-GF-CF-GF, and CF-GF-GF-CF respectively at 156.679, 146.027, and 107.260 MPa. This is caused by the cotton fabric acting as the core of this hybrid composite. As mechanical perspective base on Table 2, the GF is higher elongation number compared with CF

3.3 Tensile-Bending Average

Table 4 shows the average result between tensile and bending test, from table 1 and table 3 . Figure 5, is the visual presentation of the result. This is conducted to get the optimal configuration between tensile and bending. The results showed that GF-CF-CF-GF the highest value tensile bending test.

Table 4. Average Tensile and Bending Test Result

Variation	Tensile Average (Mpa)	Bending Average (MPa)	Tensile Bending Average(MPa)
CF-CF-GF-GF	105.04	156.679	130.86
GF-CF-CF-GF	86.00	229.996	158.00
CF-GF-CF-GF	99.52	146.027	122,77
CF-GF-GF-CF	113.30	107.260	110.28

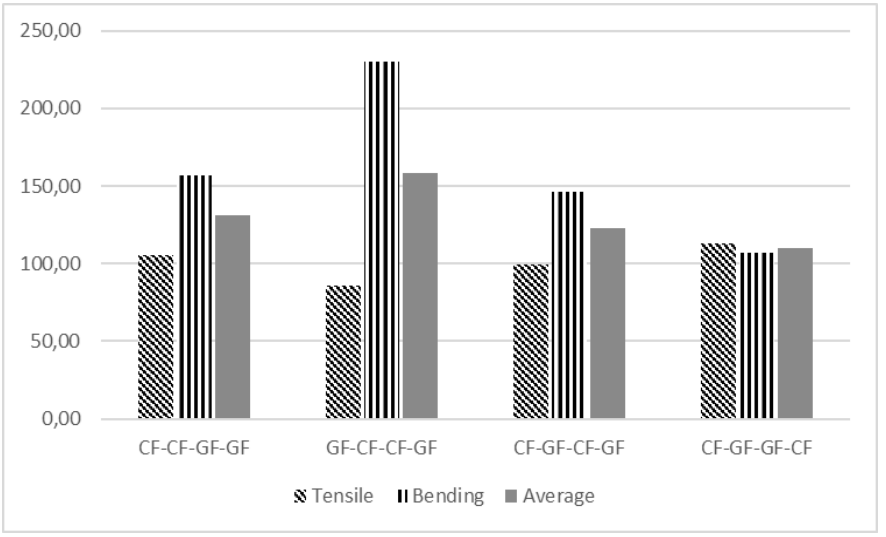

Fig. 5. Average Tensile and Bending Test Result

4 Conclusion

Highest tensile test was achieved by CF-GF-GF-CF variation at 113.30 MPa, so this configuration are suitable for making wing part of drone, commonly applied with high tensile stress. Highest bending test was achieved by GF-CF-CF-GF variation at 229.996 MPa, this oriietnation are suitable for the use manufacturingdrone fuselage part of a drone. The optimum result showed that GF-CF-CF-GF the highest average tensile bending test

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