Mechanical Properties of Polyester Matrix Composites with Carbon Hybrid Reinforcement and Woven Wire

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ABSTRACT

This study is aimed to determine the mechanical properties of composite materials using hybrid reinforcing materials, namely carbon fiber and woven wire. The variations in the composition of the matrix / carbon fiber / woven wire (in%) used were 70/0/30, 70/30/0, 70,20 / 10, 50/30/20. The mechanical tests performed were the tensile test (ASTM D 638-03) and the impact test (ASTM D 6110). The results show that the composites with the composition 50/30/20 have the highest tensile and impact strength. Specimens with the highest carbon fiber content have better tensile strength.

Keywords composite, carbon fiber, woven wire, tensile strength, impact strength
Paper type Research paper

INTRODUCTION

Composite is a material that combines two phases of material to unify the superior properties of the constituent materials. In general, the composite consists of two phases, namely the matrix phase and the reinforcing phase [1]. The matrix phase is the part that binds the reinforcing material. The reinforcing phase plays a role in bearing the force received by the composite. The reinforcing phase has an important role in determining the strength of the composite

Nowadays, carbon fiber is one of the reinforcing materials that is widely used in composite applications, especially in engineering. This fiber is widely used in the fields of aerospace, automotive industry, maritime. This is because carbon fibers have advantages in terms of specific strength, stiffness, flexibility, and have light weight [2] [3]. This advantage is very beneficial, but the opportunity to combine carbon fiber with other materials in the frame to increase the strength of the composite is still widely open.

In this study, the addition of woven wire to carbon fiber reinforced composites was carried out. Woven wire was chosen because it has good tensile strength [4] and its availability. The effect of hybrid (combined) carbon fiber and woven wire on the mechanical properties of the composite with a polyester matrix was observed. The variable used was fiber composition. The tensile and impact strength of specimens were observed.

METHOD

The specimens were made by using hand lay up method. The specimens were placing the fiber material in a composite mold that had been lubricated, then polyester resin was poured into the mold and leveled with a brush. The pressing process is carried out on the mold, then the specimen is left to dry. Furthermore, the specimen is removed from the mold and cleaned using a brush and sandpaper to remove excess dimensions. There are two types of molds used, namely molds for tensile test specimens and molds for impact test specimens. Illustrations and dimensions of tensile test specimens are shown in Figure 1 and Table 1, while the illustrations and dimensions of impact test specimens are shown in Figure 2.The variation of the composition of the polyester / carbon fiber / woven wire matrices (in%) is 70/0/30, 70/30/0, 70/20/10, 50/30/20.

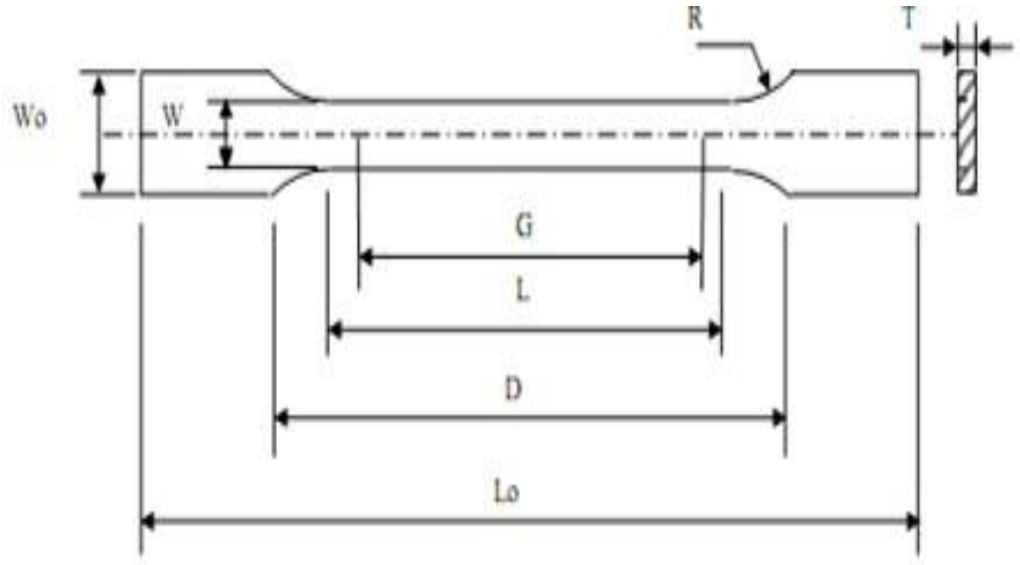

Fig. 1. Illustration of tensile test specimens according to ASTM D 638-03 standards.

TABLE I. THE DIMENSIONS OF THE TENSILE TEST SPECIMEN ARE ACCORDING TO THE ASTM D 638-03 STANDARD

Dimension	W	G	D	Lo	R	Wo	L	T
mm	19	50	115	246	78	29	57	3.2

To determine its mechanical properties, tensile and impact tests are carried out on the specimen. Tensile and impact tests were carried out on each variable 3 times per variable. The test result data is then recorded and the average value for each variable is calculated.

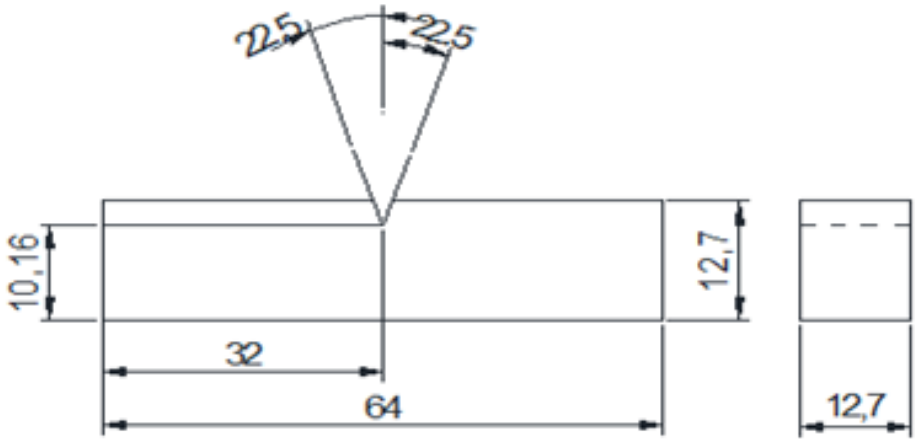

Fig. 2. Illustration of impact test specimen according to ASTM D 6110 standard.

DISCUSSION

The results of the specimen tensile test are shown in Figure 3.In this figure, the lowest tensile strength value is owned by a specimen with a composition of 70/0/30 (tensile strength 1.43 kgf/mm²), while the highest tensile strength value is owned by a specimen with a composition of 50/30/20 (tensile strength 4.54 kgf/mm²). The tensile strength of 70/0/30 specimens is almost the same as that of 100/0/0 specimens (100% polyester resin).

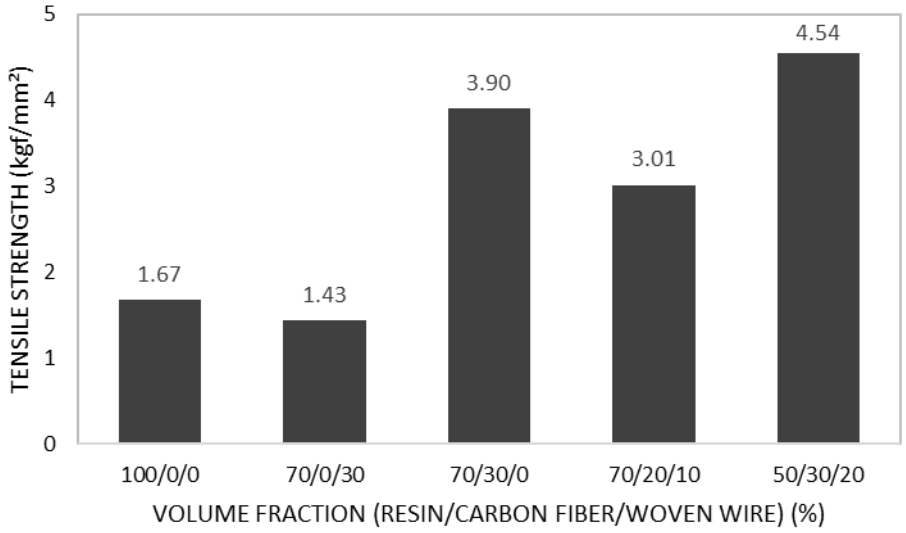

Fig. 3. Tensile strength of specimens.

Figure 4 shows the impact strength data of the specimen. The figure shows that the lowest tensile strength value is owned by a specimen with a composition of 70/0/30 (impact strength 0.0133 J/mm²), while the highest impact strength value is owned by a specimen with a composition of 50/30/20 (impact strength 0.0232 J/mm²) . The impact strength of 70/0/30 specimens is similar to that of 100/0/0 specimens (100% polyester resin).

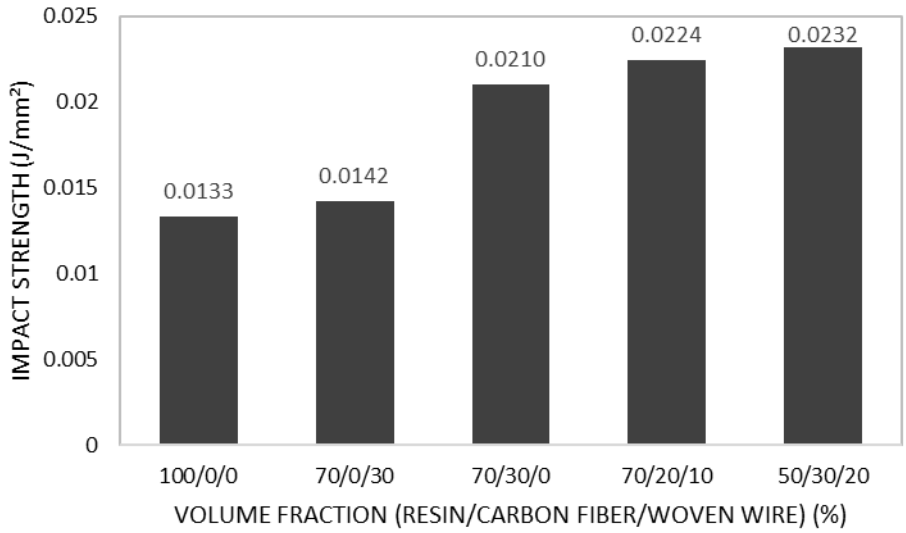

Fig. 4. Impact strength of specimens.

In **Figure 3** and **Figure 4**, it can be seen that the addition of woven wire does not give a better effect than carbon fiber. This is obviously observed from the tensile and impact strengths between 70/30/0 and 50/30/20 specimens. The addition of 20% by volume of woven wire did not result in a significant increase in strength.

According to the results of the tensile and impact test, it can be seen that carbon fiber has a more dominant influence compared to woven wire. This can be seen from the specimens 70/0/30 (30% woven wire) and 70/30/0 (30% carbon fiber). The tensile and impact strength values of the 70/0/30 specimens were 1.43 kgf / mm² and 0.0133 J / mm², respectively, while the tensile and impact strength values of the 70/30/0 specimens were 3.9 kgf / mm² and 0.021 J / mm², respectively. . From these data, it can be seen that the tensile and impact strength values of composites with carbon fiber reinforcement are about twice that of the tensile and impact strengths of wire-woven composites.

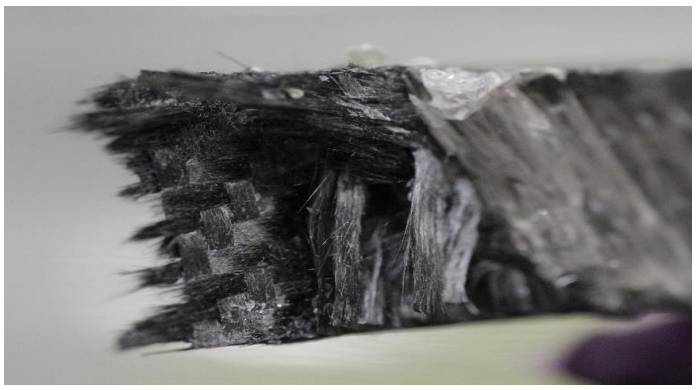

Fig. 5. The cross section of the tensile test result of the carbon fiber reinforced composite specimen.

The domination of carbon fiber in this study can be explained by **Figure 5** and **Figure 6**. In **Figure 5**, carbon fiber and resin appear to be fused, while the woven wire fiber does not appear to be fused with the matrix. This shows that carbon fiber has better adhesion (attractive force between different molecules) compared to woven wire.

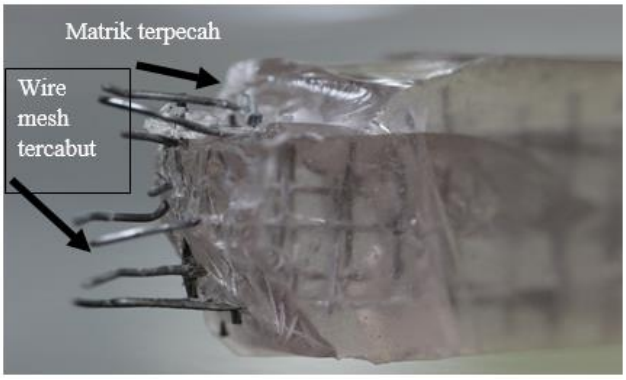

Fig. 6. The cross section of the tensile test result of the wire mesh-reinforced composite specimen.

The strength of the composite is also due to the surface contact area between the reinforcing material and its matrix [1]. In this case, the contact surface area of the carbon fiber is larger than that of woven wire. This causes the bond between the carbon fiber and the resin matrix to be greater than that of the wire-resin polyester bond. The effect of surface contact area is also described in previous studies [1] [5]. The wider surface contact increases the bond between the reinforcement and the matrix.

CONCLUSION

According to the results above, it can be concluded that the addition of woven wire did not give a more significant increase in tensile strength and impact than carbon fiber.

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