Investigation on Compression and Hardness Properties of Abaca and Manila Hybrid Composite

Article *in* Applied Mechanics and Materials · October 2014

DOI: 10.4028/www.scientific.net/AMM.680.23

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Applied Mechanics and Materials Vol. 680 (2014) pp 23-26
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doi:10.4028/www.scientific.net/AMM.680.23
Submitted: 15.07.2014
Accepted: 04.08.2014

Investigation on Compression and Hardness Properties of Abaca and Manila Hybrid Composite

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Keywords: Manila, Abaca, Glass Fibre reinforced plastic, Hybrid composite.

Abstract. Nowadays composite materials play a vital role in automotive and aerospace industries due to their important properties like high strength to weight ratio, biodegradability and ease of production. In this paper, compression and hardness properties of a hybrid composite made of manila and abaca fibers are evaluated. Hand layup process is used in this work. The result shows that hybrid composite possesses very high strength and hardness as compared to mono fibre composite.

1. Introduction

Natural fibres, due to their eco-friendly and high performance characteristics, are widely used in many applications. The consistency indices of fibrous filler-reinforced composites are larger than those of powder-filled composites; the larger the actual contact area between the matrix and the fibers, the greater the consistency index of the composite [1]. The mechanical properties of jute flax based hybrid composite were evaluated and it was found the hybrid composite posses very high strength as compared to mono fiber composite [2]. The mechanical and chemical properties of the composite can be altered by the cellulosic content present in the fibre. It was found that as the Manila fiber content in the composite increased up to 70%, there is a proportional increase in the compression and hardness properties [3]. Surface treatments resulted in enhancement of compression and hardness properties. The results showed that, treated composites have higher storage modulus and lower tangent delta with respect to untreated composite [4]. Interfacial bonding between abaca and the matrix has significantly improved, suggesting that better dispersion of the filler into the matrix has occurred upon treatment of abaca [5]. The mechanical properties of abaca- jute hybrid composites are investigated and the effect of fiber orientation on strength of materials are found [6, 7, and 9]. Mechanical and thermal properties of banana- flax hybrid composites are analysed and it was concluded that hybrid composites of flax and banana with GFRP have better thermal stability and flame resistance over flax, banana with GFRP single fibre hybrid composites [8].

2. Experimental Details

2.1 Materials

2.1.1 Manila and Abaca Fibre:

Manila is a type of buff colored fiber obtained from (*Musa Textilis*) also called as Manila hemp. Abaca is a cellulosic fibre which obtained from the pseudo-stem of banana plant (*Musa Sepientum*). The fibres are usually long and have high strength and durability.

2.1.2 Glass Fibre:

These fibres are widely used due to their high strength to weight ratio in the form of woven roved glass fibres. Glass fibre in particular is used for improving the surface finish and gives a polished look for the composite.

2.1.3 Resin and Hardener:

Epoxy resin and hardener such as LY 556 and HY 951 respectively are used in the fabrication of the composite. A preferred ratio such as 10:1 is taken to mix the resin and hardener thereby providing perfect adequate interfacial bonding.

2.2 Experimental Setup

Hand layup process is the most widely used and economical process in the manufacturing of composites. Initially, the mold is prepared with a release agent to ensure that the manufactured part can be easily removed from the mold. Then, the GFRP mat is laid over the surface and the Epoxy resin is applied along with the hardener using a brush. Hardener increases the strength of the composite. A roller is used to remove the entrapped air and also to spread the resin- hardener mixture uniformly and reduce porosity. A curing time of 6-7 hours is given. Then, the required layer of fiber combination is stacked up over the base, applying resin-hardener for getting better mixture simultaneously for each layer. Fibres are arranged in different orientations, may be vertical, horizontal or inclined after forming the required combination. This is shown in figure 1.

2.3 Fabrication Procedure:

Glass Fibre
Manila Fibre
Manila Fibre
Manila Fibre
Glass Fibre

Glass Fibre
Manila Fibre
Abaca Fibre
Manila Fibre
Glass Fibre

Glass Fibre
Abaca Fibre
Abaca Fibre
Abaca Fibre
Glass Fibre

Fig 1.Schematic diagram of Abaca-Manila–GFRP composites

The composite specimen consists of five layers. GFRP layers are placed on the top and bottom of the specimen. Intermediate layers are filled by natural fibers. Initially, releasing agent is applied on the mold board in order to remove the GFRP laminates from the mold surface. Resin and hardener mixture was applied for every layer in the ratio 10:1. A curing time of 6-7 hours is given for the top and bottom structures to obtain good strength. Finally, the fibers are closed with Woven Rovings just like the base of the laminate. Now a load of 8-10 kilograms is applied for a curing period of 8-12 hours and the mold is closed to obtain the composite laminates. Table 1 shows different samples.

Table 1: Different composite samples

Samples	**Composition**
Sample 1	GFRP +Manila + GFRP
Sample 2	GFRP +Manila + Abaca + GFRP
Sample 3	GFRP +Abaca + GFRP

3. Testing

3.1 Compression Test:

This testing method depicts the load bearing capacity of the Manila/Abaca composite. The specimen is prepared as per ASTM D: 256 standards. The specimen is inspected and loaded in the compression testing machine after it is machined properly. Here, three specimens of varying thickness are taken and tests are conducted to find the average value of compression strength and values are tabulated .This material property is useful for designing and various other applications.

3.2 Rockwell Hardness test:

The Rockwell Hardness test is an indentation hardness test and is useful for material selection. This testing method consists of the process of determining the hardness by measuring the depth of penetration of an indenter under a specific load. The hardness test results of Manila/Abaca fibre material are determined in "D" scale. From Table 3, it is found that sample 2 has the highest HRD value of 462.8. So, sample 2 can withstand more aberrations than the other samples.

4. Results and discussion

4.1 Compression test:

Table 2: Result of compression test for different composite

Sample	Specimen thickness (mm)	Compressive strength (MPa)
Sample 1	5	668.6
	6	675.9
	7	672.3
Sample 2	5	710.3
	6	715.9
	7	712.5
Sample 3	5	683.4
	6	679.5
	7	676.6

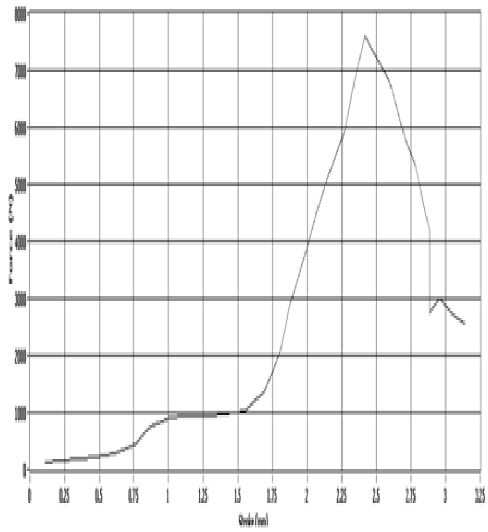

Fig 2: Compression test results (Sample2)

From Table 2 it is concluded that Abaca + Manila+ GFRP composite (Sample 2) has better strength than hybrid composite (Sample 2) and shown in figure 2.

4.2 Rockwell Hardness test:

Table 3: Result of hardness test for different composites

Specimen	Hardness Values: HR "D"
Sample 1	452.6
Sample 2	462.8
Sample 3	448.7
Average	454.7

From Table 3, it is clear that sample 2 has better hardness properties than hybrid composite (Sample 3). This happens due to the presence of Manila fibre.

Conclusion

In this paper, epoxy has been used as a resin and Manila and Abaca are used as reinforcements with GFRP. Compression and hardness tests were carried out and result of the tests were tabulated. Test results of Sample 2 exhibits the best compression and hardness properties among the three samples. The average values of hardness and compression strength properties of Abaca and Manila are very closer to each other.

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