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Fabrication of Carbon Fibre Bike Mudguard

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Abstract

Carbon fiber composites are moving into the main stream for the automobile industry, and also in aircraft industries, they are even finding more places to discover themselves. Basically, Carbon fibers are the man-made artificial fibers. These fibers have high strength to weight ratio when compared to that of Natural fibers and artificial fibers such as Glass, Aramid and Kevlar etc. In this project carbon fiber is embedded in a biopolymer matrix system (epoxy), the task of which is to hold the fibers together, this provides and stabilizes the shape of the composite structure, transmits the shear forces between the mechanically high-quality fibers, and protects them against radiation and other aggressive media and the specimen is prepared. The component is conditioned and prepared for testing and subjected to tensile test and bending test and compared to the existing part.

Key words: Carbon fiber, Epoxy, Composite, Specimen, Existing part.

1. Introduction

With the new developments and discoveries the industry of manufactured fibers is diversified. More new fibers can be obtained from this rather than that available from nature. After the world war –II major industries start new developments and discoveries for the new fibers having the unique qualities.

These are fibers made for some special applications and these fibers are like Aromatic polyester e.g. vectran and econol and Aromatic polyamide/aramid e.g. Twaron, Nomex and Kevlar. In the early 1990 some super fibers were being discovered like glass fiber, composite fiber, ceramic fiber and carbon fiber which are completely inorganic fiber. Manufactured fibers have varied no. of applications when it comes in the area of industrial uses and these applications comprise of construction materials for moon-based space stations, super-absorbent diapers and artificial organs and engineered non-woven products were used in the roofing materials, floppy disk envelopes, road bed stabilizers, apparel interfacing and surgical gowns. These non-woven fabrics are made without weaving or knitting and it could be anything as soft and comfortable as limp cloth and as stiff as paper.

1.1 Epoxy resins

Epoxy resins are mostly used in aerospace structures for high performance applications. It is also used in marine structures, rarely though, as cheaper varieties of epoxy resins other than epoxy are available.

The extensive use of epoxy resins in industry is due to: (1) the ease with which it can be processed, (2) excellent mechanical properties in composites and (3) high hot and wet strength properties (1500°C). Performance of epoxies is

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superior to polyester resins due to their superior mechanical properties and better resistance to degradation by water and other solvents.

The chemistry of the epoxy resin components is such that it gives a better adhesion to reinforcing fiber than polyester resins.

1.2 Hardener

Generally in a composite material epoxy (also known as resin) is mixed with a hardener to get more amount of strength, hardness etc., These hardeners increase the properties of composite. In general fiber will be having some properties in the same way as epoxy and hardener too. Combination of all these properties together can give a material simply known as composite material and this will be having all the properties of fiber, epoxy and even hardener.

1.3 Carbon fibers

Carbon fibers are used for reinforcing certain matrix materials to form composites. Carbon fibers are unidirectional reinforcements and can be arranged in such a way in the composite that it is stronger in the direction, which must bear loads. The physical properties of carbon fiber reinforced composite materials depend considerably on the nature of the matrix, the fiber alignment, the volume fraction of the fiber and matrix, and on the molding conditions. Several types of matrix materials such as glass and ceramics, metal and plastics have been used as matrices for reinforcement by carbon fiber.

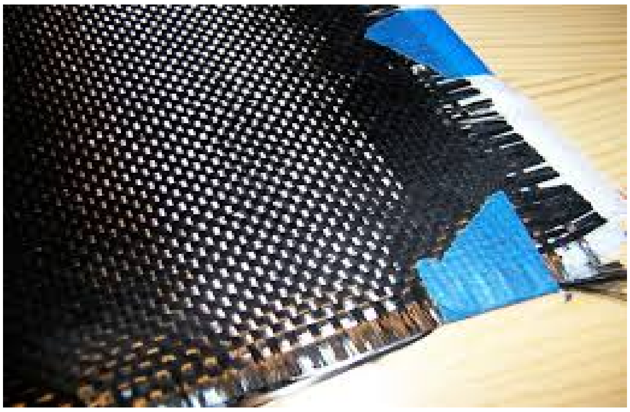

Fig. 1.3 Carbon Fiber

Carbon fiber composites, particularly those with polymer matrices, have become the dominant advanced composite materials for aerospace, automobile, sporting goods and other applications due to their high strength, high modulus, low density, and reasonable cost for application requiring high temperature resistance as in the case of spacecrafts.

2. Preparation of Specimens

Epoxy is used as resin here and it is mixed with the hardener in the ratio of 2:1. This is done to get good, resisting and strong properties which can result in effective composite material. They are mixed effectively and briskly and used soon with the reinforcement as the epoxy has the nature of solidifying fast. Since the epoxy is a thermosetting one this care to be taken whiles the preparation of specimen.

2.1 Preparation of Bike Side cover.

The pattern of the part is taken and wax is applied on it so as to eliminate the stickiness between pattern and composite. The resin is applied on it. On each application of resin it is to be remembered that it is allowed to dry for a while. Then a layer of fiber is laid on it and it is pressed gently on to each side and corners of the pattern. Like this after application of two layers of fiber finally a final coating of resin is laid on it and this finishes the process. Care should be taken that while preparing the material need to wear gloves to avoid skin infections or any allergies.

The material is to kept aside and made to dry for 24-36 hours for an effective part with good properties that are better than the plastic part. Here this side part consists of two layers of carbon fiber.

Care should be taken while applying the resin as it may lead to bubbles on the composite surface. And also while pressing the carbon cloth on the pattern it should able fill the each corner of it. And while removing of composite from pattern it should be removed carefully by not causing any damage to the composite.

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Fig. 2.1 Final product

2.2 Preparation of Bike Mudguard

The preparation of mudguard is as similar to that of the side part. Firstly, a thick layer of wax is applied on it. Depending on the applied thickness of wax the flexibility of removal of composite from pattern depends. Resin is applied on it and dried for a while. Here we used hair drier to make the resin to dry. Then first layer of carbon cloth is laid on it. And resin is again applied on it.

Like this totally three layers of carbon fiber are laid on the pateern and ending with the final coating of resin over it.

Fig. 2.2 Pattern

Fig. 2.3 Process

Fig. 2.4 Finished Mudguard

By the above steps the mudguard can be made by making it to dry for a time period of 24-36 hours. And it can be removed from the pattern.

The final product (that is mudguard) is obtained as shown below and this is having the better properties than the plastic material.

Fig. 2.5 Plastic & Carbon Fibre Mudguard

2.3 Preparation of Specimens for Testing

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For testing the mechanical properties of the composite material and comparing them with plastic material the specimens are made separately according to the standards and required number of layers of composite. This can be done with a rectangular tray made of G.I sheet with required dimensions and with required number of layers. These specimens can be made of three layers and five layers.

Fig. 2.6 Specimens for testing

For testing purpose two specimens of plastic are considered. And composite of three layer of carbon fiber are prepared for tensile and bending tests. As we know that as the number of layers increases automatically all the properties increases. So, for this purpose a five layered composite are made for the tensile and bending tests.

3. Testing & Results

For testing seven specimens among those seven specimens three for tensile test and three for bending and one is for finding the hardness of the material. In these three tensile specimens one is plastic piece; one is three layers of fiber and having five layers of fiber composite.

3.1 Tensile Test

Tensile properties often are measured during development of new materials and processes, so that different materials and processes can be compared. Finally, tensile properties often are used to predict the behaviour of a material under forms of loading other than uni axial tension.

3.1.1 Tensile test for Plastic specimen

This testing is done on a plastic piece to compare it with composite specimen with following dimensions.

Length (L) =140 mm

Width (B) =14.17 mm

Thickness (T) =2.65 mm

Cross sectional Area (A) =37.551 mm^2

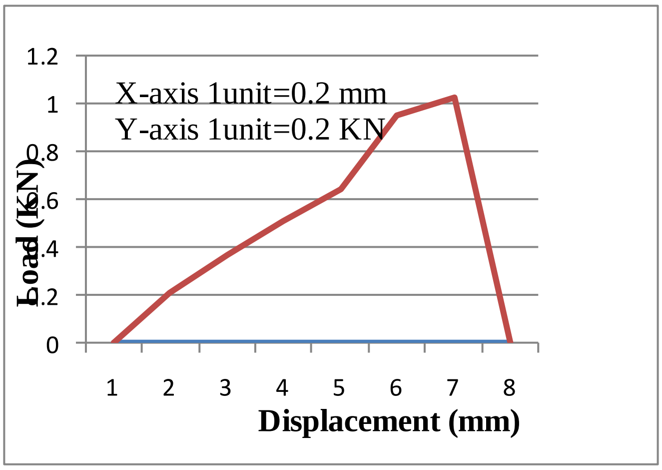
The gauge length marked on specimen = 60 mm

The results of the 1st specimen are shown below

Ultimate load=1000 N

Ultimate stress = 1000/37.55 = 26.631 N/mm^2

The below graph shows the load distribution over displacement



Graph 3.1 load distributions over displacement for plastic specimen.

3.1.2 Tensile test for 3 layer carbon specimen

The specimen is with the following dimensions

Length (L) =140 mm

Width (B) =16.38 mm

Thickness (T) =1.94 mm

Cross sectional Area (A) =31.78 mm^2

The gauge length marked on specimen = 60 mm

These results are taken from the experimental values and graph.

The results of the specimen are shown below

Ultimate load=1257 N

Ultimate stress =1257/31.78 = 39.55 N/mm^2

3.1.3 Tensile test for 5 layer carbon specimen

The specimen is with the following dimensions

Length (L) =140 mm

Width (B) =15.9 mm

Thickness (T) =2.56 mm

Cross sectional Area (A) =40.704 mm^2

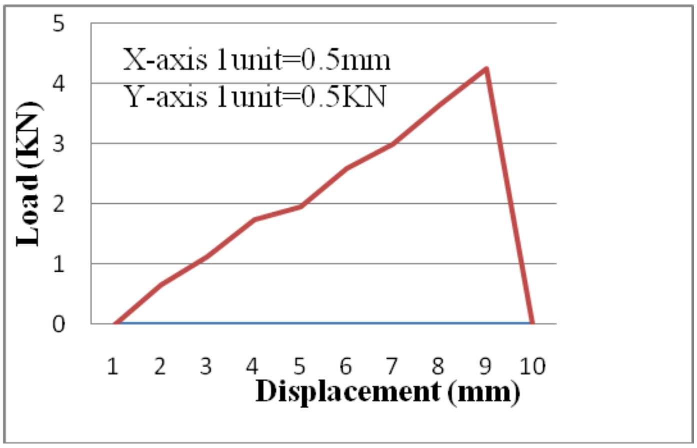
The gauge length marked on specimen = 60 mm

The results of the specimen are shown below

Ultimate load=4480 N

Ultimate stress=4480/40.704 = 110.7 N/mm^2

The below graph shows the load distribution over displacement.



Graph 3.2 load distributions over displacement for carbon 5 layer specimen.

3.2 Bending Test

For bending test, the specimen is kept in the UTM as shown in the above figures. The bending load of three specimens plastic, 2-layer composite, 5-layer composite materials can be calculated.

Fig. 3.2 Specimen under Load

The below figure shows the tensile and bending specimens after testing (Breaking).

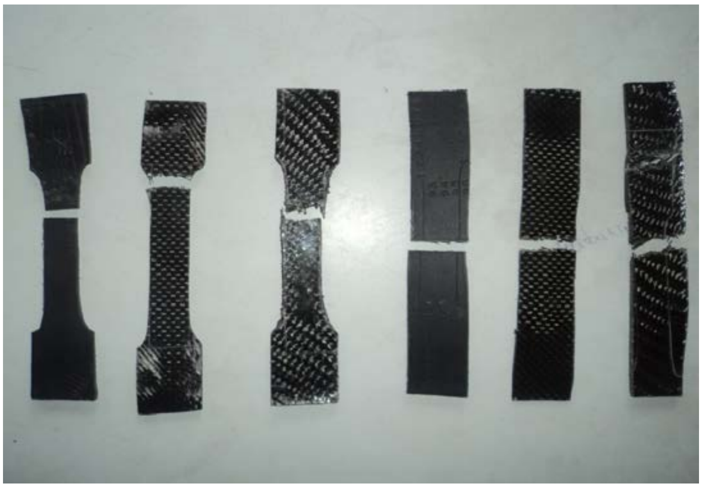


Fig. 3.3 Specimens after breaking

4. Comparison Parameters

4.1 Weight comparison

The weight place a crucial role in the fuel efficiency of a motor vehicle. So, the weight comparison is done for the plastic part, side part (which is made with two layers of composite) and mud guard (which is made with three layers composite). This is as shown in the table.

Table 4.1 Comparison between weights

	Part	Material	Weight (in gms)
1	Side part	Plastic	270
		Composite	135
2	Mud guard	Plastic	500
		Composite	340

4.2 Loads and Stresses comparison

Depending on the loads that a material can resist the strength, stresses acting on the material can be calculated. So, here the testing is done on the materials by comparing between plastic and composite material. We have done mechanical tests such as tensile test, bending test to calculate the stresses, flexural strength of the composite. And there is a difference between the two materials and this comparison is shown below.

Table 4.2 Comparison between Loads and Stresses

	Plastic	3-Layer Composite	5-Layer Composite
Ultimate Load(in N)	1000	1257	4480
Ultimate Stress (in N/mm^2)	26.63	39.55	110.7
Bending Load (in N)	100	200	600
Bending Stress (in N/mm^2)	159.273	702.36	944.68
Flexural Strength (in N/mm^2)	211.04	681.29	1209.19

4.3 Comparison between other parameters

The difference between other parameters such as Cost, Strength and Weight also considered in the comparison of composite with the existing one.

Table 4.3 Comparison between other parameters

	Other Parameters	Plastic Material Product	Composite Material Product
1	Tensile Strength	Less	More
2	Thermal Expansion	Moderate	Low
3	Stiffness(Strength to Weight Ratio)	Higher	Lower
4	Weight	More	Less
5	Cost	Rs.1000-1200	Rs.1500(in mass production)
6	Durability	Less life	Long life

Many such factors and parameters can be compared between the Plastic and Composite material.

5. Conclusion

This work shows that successful fabrication of a carbon fiber reinforced epoxy composites by simple hand lay-up technique. The product is successfully prepared and it is tested mechanically. And the results of the product are compared to that of the existing one and found to be more capable than the present one. The results indicate that due to increase in the layers of fiber the strength of the composite material increases. Here fiber loading and size are the significant factors in effecting the strength of the material.

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