

Analysis of Carbon Fiber Reinforced Composite Using ACP

Mr.J.Jaison¹, Mr.J.Jem liborious², Mr.J.Jeyson³, Mr.G.Kumaresan⁴, Miss.G.L.Linastefi⁵

Assistant Professor, Department of Mechanical Engineering, Francis Xavier Engineering College, Vanarpettai,
Tirunelveli, Tamil Nadu, India¹

Students, Department of Mechanical Engineering, Francis Xavier Engineering College, Vanarpettai, Tirunelveli,
Tamil Nadu, India^{2,3,4&5}

ABSTRACT: Carbon fiber is composed of carbon atoms bonded together to form a long chain .These fibers are extremely stiff , strong and light, and are used in many processes to create excellence building materials .Specimens have been prepared using compression moulding process with ASTM standards. Tensile strength test has been carried out in a computerized Universal Testing Machine (UTM). Flexural strength test have been carried with the help of relevant test set ups. The various strength values of the specimens have been compared for choosing better combination of carbon fiber composite structure. In addition to that numerical analysis have been performed using ANSYS (ACP module for validation purpose). All mechanical strength test results reveal that carbon fiber composite specimen exhibits higher strength values.

I. INTRODUCTION.

A composite is combination of two materials in which one of the materials, called the reinforcing phase, is in the form of fibers, sheets, or particles, and is embedded in the other materials called the matrix phase. The reinforcing material and the matrix material can be metal, ceramic, or polymer. Composites typically have a fiber or particle phase that is stiffer and stronger than the continuous matrix phase and serve as the principal load carrying members. The matrix acts as a load transfer medium between fibers, and in less ideal cases where the loads are complex, the matrix may even have to bear loads transverse to the fiber axis. The matrix is more ductile than the fibers and thus acts as a source of composite toughness. The matrix also serves to protect the fibers from environmental damage before, during and after composite processing.

The physical properties of composite materials are generally not isotropic (independent of direction of applied force) in nature, but rather are typically anisotropic (different depending on the direction of the applied force or load). A recently developed concept of composite is that the composite should not only be a combination of two materials, but the combination should have its own distinctive properties. In terms of strength, heat resistance, or some other desired characteristic, the composite must be better than either component alone.

II. PREPARATION OF SAMPLES

For carrying out this work, with the carbon fiber has been chosen for preparing composite structure. Epoxy resin has been selected as matrix materials. The mechanical properties of the selected fibers and resin materials have been tabulated below in table 4.1.

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Table 4.1: Mechanical properties of fiber and matrix materials

S.No.	Properties	Epoxy Resin	Carbon fiber
1.	Young's Modulus (GPa)	3	8
2.	Poisson's Ratio	0.4	0.30

Composite material fabrication can be broadly classified into following categories:

- Hand lay up
- Vacuum bag moulding
- Compression moulding
- Pressure bag moulding

Compression Moulding

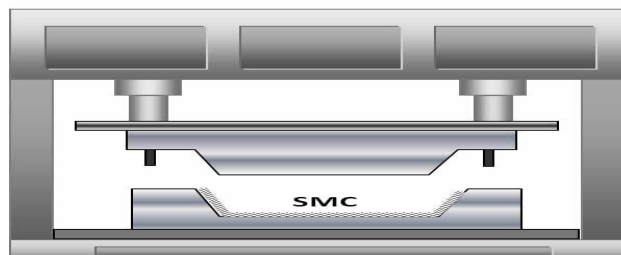


Figure:4.2 compression moulding

Composites are formed by placing fibers impregnated in resin on to female mould and applying pressure using a male mould to eliminate any excess resin from the ACM compression moulding is useful for fabrication such as boat hulls. In this project compression moulding process is used for fabrication of composite. The size of the composite sheet that is to be fabricated is 300*150*5 the materials used for fabrication are:

- Die- 300*150*5
- Epoxy LY556& hardener HY951
- Carbon fiber

The die is used to fabricate the composite in the cross section of 300*150*5. Initially the grease is applied over the female die. After that OHB sheet is placed over it. The hardener grade 951 will be added to the epoxy resin. Which is used to increase the hardness of the epoxy resin.

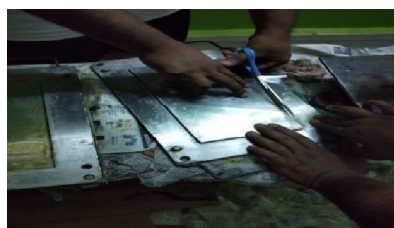


Figure: 4.3 preparation of die

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The carbon fiber is cut in dimension of 300*150mm the epoxy resin is mixed in the ratio of 10:1 and stirred slowly in order to avoid air bubbles. The various layers are used for making the specimen First the resin is equally poured on the die and carbon fiber will be placed above the die with correct dimension. Again the resin is equally distributed over the fiber. After that the specimen is allow them to dry for 24 hours in compression moulding. It gets the single layer of the composite specimen. The cycle is repeated to obtained the required layers of composites

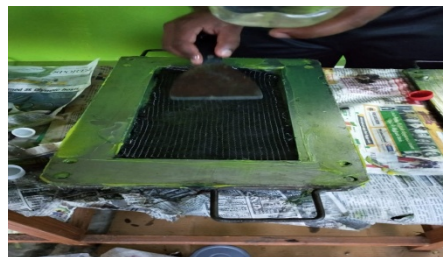


Figure: 4.4 layer formation



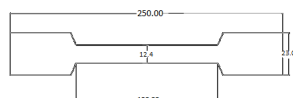
Figure:4.5 fabricated material

And thus fabrication is completed by means of compression moulding. The finished specimen is used to under go the strength analysis for analysing its mechanical behaviour such as tensile strength, flexural strength, impact strength and water absorption. The testing are done in both experimentally and numerically (using ANSYS)

III. EXPERIMENTAL ANALYSIS

Mechanical properties like ultimate compressive strength, ultimate tensile strength, impact strength, hardness, flexural strength and water absorption test will be evaluated.

Tensile test: Tensile testing, also known as tension testing, is a fundamental materials science and engineering test in which a sample is subjected to a controlled tension until failure. Properties that are directly measured via a tensile test are ultimate tensile strength, breaking strength, maximum elongation and reduction in area.



all dimensions are in mm

Figure 5.2: Tensile ASTM A378

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Table 5.1: Tensile strength result

	Layer sequence			
	1 carbon fiber	2 carbon fiber	3 carbon fiber	4 carbon fiber
Cross sectional area	73.82mm ²	76.00mm ²	96.98mm ²	103.38mm ²
Load at yield	1490N	1305N	4010N	5760N
Yield strength	20.15MPa	17.144MPa	41.32MPa	55.95MPa
Load at peak	2130N	2530N	6740N	11386.6N
Elongation at peak	1.55mm	11.92mm	6.22mm	5.42mm
Tensile strength	28.87MPa	33.29MPa	67.97MPa	110.6MPa

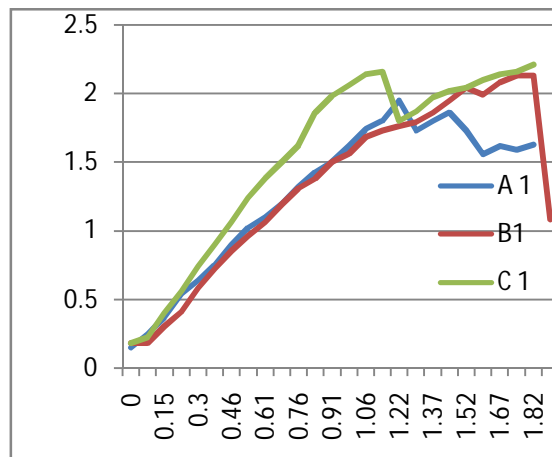
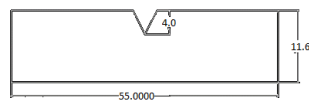


Figure 5.5: Load vs displacement curve single layer

The above chart shows the effect of reinforcements on UTS of the Fibers reinforced composites as can clearly see the increase in the ultimate tensile strength in single layer carbon fiber composite. A1,B1,C1 are the single carbon layer samples which are tested under the different load. The graph is plotted between load vs elongation of specimen i.e .displacement.

Impact test: The apparatus consists of a pendulum of known mass and length that is dropped from a known height to impact a notched specimen of material. The energy transferred to the material can be inferred by comparing the difference in the height of the hammer before and after the fracture.



all dimensions are in mm

Figure 5.3: Impact test ASTM standard

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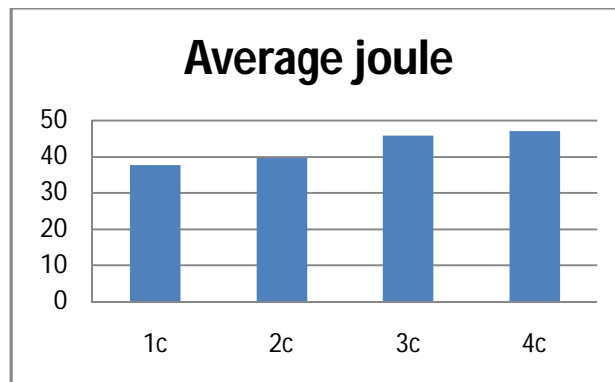
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Sl. No.	Material	Energy absorbed by specimen (J)	Behaviour of specimen	Impact strength(J/mm ²)
1	C	2	broken	3.63×10^{-3}
2	c/c	3.6	broken	6.54×10^{-3}
3	c/c/c	3.8	broken	6.9×10^{-3}
4	c/c/c/c	4	broken	7.27×10^{-3}

Table 5.3: Impact test result



Flexural strength: Flexural strength, also known as modulus of rupture, bend strength, or fracture strength a mechanical parameter for brittle material, is defined as a material's ability to resist deformation under load. The transverse bending test is most frequently employed, in which a rod specimen having either a circular or rectangular cross section is bent until fracture using a three point flexural test technique.

Table 5.2: flexural strength result

	Layer sequence			
	1 carbon fiber	2carbon fiber	3carbon fiber	4 carbon fiber
Ultimate load	180N	60N	375N	580N
Max. elongation	7.37mm	3.105mm	14.44mm	13.55mm
Flexural strength	2.76MPa	1.045MPa	5.47MPa	8.093MPa

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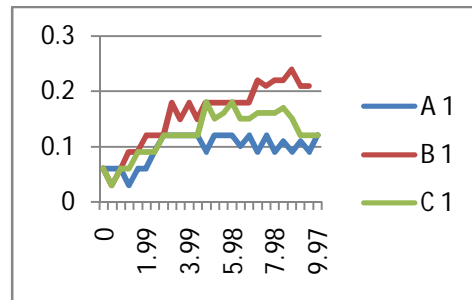


Figure 5.10: load vs displacement curve for flexural strength

The graph was drawn between the load and displacement. From the above graph the load increases the flexural strength decreases. The above graph is the single layered carbon fiber sample which is tested with three pieces of A1, B1, C1.

IV. CONCLUSION

By comparing Tensile stress Results of Experimental Analysis and numerical analysis. From the test results of carbon fiber composites based on mechanical tests conducted a conclusion is reached from the study. All the result are compared to various proposition of carbon fiber to increase the strength. From the study it's concluded that the composites used in aerospace and aeronautical applications abundant and highly reliable. carbon fiber composite material result of tensile strength [110.6MPa] is increase with increase of carbon fiber layer .

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