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## Vacuum Bag Technology for Obtaining Carbon / Epoxy Composites

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**ABSTRACT**: In this paper, the new composite manufacturing process is introduced and compared with the conventional manufacturing process such as compression moulding, hand layup, Resin Transfer Moulding and etc. The new technology is known as Vacuum Bagging. This study is about reinforced carbon fiber processed with epoxy resin by using vacuum bag technology. Carbon / Epoxy composites are widely used in aerospace, marine, automobile and manufacturing industries. Two samples are fabricated. Sample 1 is fabricated by vacuum bagging and Sample 2 is fabricated by hand layup. For these samples, the physical and mechanical properties are evaluated. The specimen preparation refers to ASTM standards.

KEYWORDS: Vacuum Bagging, Carbon/Epoxy composites

#### I. INTRODUCTION

Conventionally, Carbon/Epoxy composites are fabricated by compression moulding, Hand layup, Autoclave moulding, Resin Transfer moulding and etc. components produced by these manufacturing processes are not good in surface finish and having lots of defects. Fibre to resin ratio important while manufacturing carbon/epoxy composites. The perfect fibre to resin ratio is obtained in vacuum bagging. But in other processes, the resin content is high in nature and the resin properties are higher in the composites. Aerospace and marine industries are concentrated on the weight reduction. Strength to weight ratio is also important while making composites. The light weight components with high strength to weight ratio is obtained through this vacuum bag setup. Compare to this method, the installation cost is higher and not portable. Vacuum bag size is varied with the size of the mould. Vacuum pump is the heart of this manufacturing process. Pump selection plays a major role in this method. Perfect vacuum cannot be obtained by the vacuum pump.



Figure 1 - vacuum bag setup design



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#### **II. FABRICATION DETAILS**

Sample 1 is fabricated using vacuum bagging method. The  $90 \times 90$ mm square plate is selected as a mould. Mould wax is applied on the surface of the mould 4 to 5 times. The vacuum bag is selected for the required mould size. First the full vacuum bag setup is assembled. Then the epoxy resin and hardener is taken 10:1 ratio. After applied the layers the mould is set into the bag. Now the bag is sealed and check for the leak. Before applying the vacuum, the pressure inside and outside the envelope remains same as atmospheric pressure. After applying the vacuum, the pressure inside the envelope decreases. The pressure difference between inside and outside of the envelope creates the clamping force. The curing time of the process is about 3 to 4 hours. Throughout the process, the pressure inside the envelope remains same. Finally the sample 1 is taken out from the bag. The sample is cut for the required dimensions for the testing purpose. The sample preparation refers to ASTM standards.



Figure 2 – vacuum bag setup

Sample 2 is fabricated using hand layup method. The same size mould taken for this method also. Mould wax is applied 4 to 5 times. The layers and resins are taken for the same amount similar to the vacuum bagging. After applying the layer and resins the mould is placed on the open room. It is cured in the presence of air. Then the sample is removed from the die and the excess of the piece is removed by the wire cut machine. The required dimensions for the testing are marked and to be cut using the wire cut machine as per ASTM standard.



Figure 3 – finished component

#### **III. EXPERIMENTAL DETAILS**

The physical and mechanical properties are to be tested. The physical properties such as mass, thickness, volume and density of the two samples are to be tested. Physical properties can be observed and measured without changing or breaking the sample. Weighing scale is used to measure the weight of the sample. Digital weighing scale is more accurate than the analog scale. So we are using digital weighing scale to measure the sample piece. Thickness of the specimen is measured by various measurement tools. But we use Vernier caliper to measure the thickness of the



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sample. Vernier caliper is used to measure the outer dimensions of object using main jaw and to measure the inside dimensions using smaller jaw on the top.

ASTM D3039 is the standard for testing the tensile properties of the composite materials. The test is conducted on the (UTM) universal testing machine. By this tensile test we determine the in-plane tensile properties of polymer matrix composite materials strengthened by high-modulus fibers can be obtained. Tensile test indicate how the material will react to forces being applied in tension. A tensile test is a fundamental mechanical test where a carefully prepared specimen is loaded in a very controlled manner while measuring the applied load and the elongation of the specimen over some distance.

ASTM D7264 is the standard for flexural test of the composite materials. The test is conducted in the (UTM) universal testing machine. The test is carried out by the three-point testing method. Standard specimen thickness is 3mm and width is 13mm and it is 125mm long. From the experiment compressive strength (MPa), maximum displacement (mm) and ultimate load can be calculated. The flexural strength of a material is defined as ability to resist deformation under load.

Charpy impact strength test is an ASTM standard method of finding the impact resistance of materials. The test is conducted in the impact testing machine. ASTM D256 is the standard for the composite materials. The dimensions are  $63.5 \times 12.8 \times 3.2$  mm. And a  $22.5^{\circ}$  V notch is cut in the center of the samples. From the above mechanical properties, the efficiency of the fabrication methods is evaluated.

Rockwell is a method of hardness testing that simply believes on the metal's resistance to indentation using a specific load application and a specific indenter. It has two load systems for measurement, which is minor load and major load. The Rockwell hardness test is defined in ASTM E 18 and several other standards.

#### **IV. RESULT AND DISCUSSION**

The physical properties of the composite materials such as weight, area, volume, density and thickness for both samples are taken. the size of the sample mould  $90 \times 90 \text{ mm}^2$ . The following table shows the physical properties of the samples. Both samples are made by 3layers of carbon fibre reinforcement polymer. The result shows the thickness of sample 1 is less than the sample 2. Compare to sample 2, there is a weight reduction in sample 1 that is made by vacuum bag setup. Vacuum bag setup (sample 1) shows the better physical property than hand layup (sample 2).

	Area	Volume	Density	Mass	Thickness
	( mm^2)	( mm^3)	( Kg / m^3)	(grams)	(mm)
Sample 1					
(VBS)	8100	9720	1337.45	13	1.2
Sample 2					
(hand layup)	8100	18630	966.18	18	2.3

Table 1 – physical properties of the samples

The mechanical properties such as tensile, flexural, impact and hardness test for both samples are taken. The mechanical properties of the samples are evaluated and shown in the table 2. The tensile strength of the Sample 1 (Vacuum bagging) is comparatively high with Sample 2 (Hand Layup), this is because of the heat treatment and the sample is kept in the above the room temperature, whereas the Sample 2 (Hand Layup) is kept in the room temperature while fabrication. It is noted that the tensile strength of the samples is satisfied. So, the stability of the Sample 1 (Vacuum bagging) is enough. The flexural strength of the sample 1 (Vacuum bagging) is higher than the Sample 2 (Hand Layup) this is due to the weight ratio of the reinforcement and matrix is low when compared to the Sample 2 (Hand Layup). This shows that the carbon fibre has the better flexural strength than the epoxy resin.

The Sample 1 (Vacuum bagging) is having better hardness than the Sample 2 (Hand Layup). This shows that the excess resin content in the top layer of the hand layup method. This cause the hardness of the Sample 2 (Hand Layup) is comparatively lesser than the Sample 1 (Vacuum bagging). From the results it is clear that the impact strength also better in the Sample 1 (Vacuum bagging) prepared by the vacuum bagging.



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	Tensile strength (MPa)	Flexural strength (MPa)	Impact strength (KJ/m^2)	Hardness (RHN)
Sample 1 (VBS)	271.4	226.8	0.733	87
Sample 2 (hand layup)	234.1	198.4	0.708	82

Table 2 – mechanical properties of the samples



Figure 4 – Tensile, flexural and hardness values of the samples

#### **V. CONCLUSION**

The sample prepared by vacuum bagging method shows the better result in the both physical and mechanical properties. The defects such as air voids, flow line are also reduced in the sample 1 made by vacuum bagging method. The main cause of the improvement in the mechanical properties is because of the fabrication methods. It shows that the fabrication methods can be a reason for the difference in the mechanical properties. The sample 2 made by hand layup is having resin properties because of the excess resin in the mould. The excess resin content is absorbed in the peel ply in the vacuum bag setup so the perfect fiber to resin ratio is obtained. High strength with less weight components are now highly used in aerospace, marine and automobile industries. So that, vacuum bag technology shows the better result for making composite materials.

#### REFERENCES

[1] K Abdurohman1, T Satrio1, N L Muzayadah1 and Teten21 Aeronautics Technology Center, National Institute of Aeronautics and Space(LAPAN), Indonesia 2 Universitas Nurtanio, Bandung, Indonesia. A comparison process between hand lay-up, vacuum infusion and vacuum bagging method toward e-glass EW 185/lycal composites

[2] M. Lakshmi Aparna, Dr. G. Chaitanya, Dr. K. Srinivas and Dr. J. Appa Rao, "Fabrication of Continuous GFRP Composites using Vacuum Bag Molding Process", International Journal of Advanced Science and Technology, Vol.87 (2016), pp.37-46

[3] Mohan Kumar, S., Raghavendra Ravikiran, K. and Govindaraju, H. K. (2018) 'Development ofE-Glass Woven Fabric / Polyester Resin Polymer Matrix Composite and Study ofMechanical Properties', Materials Today: Proceedings. Elsevier Ltd, 5(5), pp. 13367–13374.

[4] Prashant MeshramSonikaSahu et al. 2017 Study on mechanical properties of epoxy andnylon/epoxy composite. ScienceDirect Materials.

[5] Channabasanagouda S Patil, Fabrication of Composite Material (Jute fibre) Using Vacuum Bagging Equipment \*(Thermal Power Engineering, VTU Belgaum/VDIT, Haliyal, Karnataka.

[6] 1Prasad Ram Devali, 2Preetam Pai, 3Shreyas Subhas Kamath, 4Vignesh BStudy on Mechanical Properties of Glass/Satin/Epoxy Hybrid Composites Fabricated Through Vacuum Bag Moulding Students, Department of Mechanical Engineering Canara Engineering College, Mangalore, India



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