Low Velocity Impact Analysis on Fibre Reinforced Polymer Composite Material

Abhinav Suman [1], Soumitra Mandal[2], Harsh Kumar[3], Rakesh Kumar[4], Shivasharanayya swamy[5]
[1, 2, 3, 4] Dept OF Mechchanical Engineering
[5]asst. Prof, Dept OF Mechchanical Engineering
[1, 2, 3, 4, 5] Reva Institute Of Technology And Management, Bangalore

Abstract*- As the application of fibre-reinforced polymer composite material continue to increase day by day, so the knowledge about the impact behavior of fibre-reinforced polymer composite structures in the areas such as automotive and aerospace is very much needed. This report attempts a comprehensive review of recent literature in the broader area of impact damage. Testing methods and standard parameters as well as discussion of important aspects such as impactor shape, weight of impactor, velocity of impact, environment in which impact takes place are presented. Furthermore, the damage area, energy absorbed, contact time and many other considerations are discussed.*

Keywords- Carbon fibre, Glass fibre, Epoxy resin, Hardner, Charpy Impact test, Drop weight impact test.

I. INTRODUCTION

In the last few decades, the use of composite materials in different structures has become increasingly popular since composites are well known for their excellent weight/strength and weight/stiffness properties and this makes them the material of choice for lightweight structures. Laminated fibre-reinforced composite materials are also known for their good environmental resistance and fatigue resistance. Previously, light alloys were widely used in aircraft. However, composites have now replaced light alloys in aircraft structures since they have a lower maintenance control surface. Aircraft structures need to be constructed using material that possesses high durability, high hardness and light weight.

II. MATERIAL USED

Materials used for the preparation of Polymers: Epoxy Resin, Hardener. Materials used for the reinforcement of Polymers: Carbon Fiber, Glass Fiber.

2.1 Carbon Fibre

Carbon fibre are are fibers about 5–10 micrometers in diameter and composed mostly of carbon atoms. Carbon fibers have several advantages including high stiffness, high tensile strength, low weight, high chemical resistance, high temperature tolerance and low thermal expansion. These properties have made carbon fiber very popular in aerospace, civil engineering, military, and motorsports, along with other competition sports. However, they are relatively expensive when compared with similar fibers, such as glass fibers or plastic fibers. Carbon fibre used in the experiment is show in figure 2.1.

Figure 2.1: Carbon fibre used in experiment

2.2 Glass fibre

Glass fibre is a material consisting of numerous extremely fine fibers of glass. Glass fiber has roughly comparable mechanical properties to other fibers such as polymers and carbon fiber. Although not as strong or as rigid as carbon fiber, it is much cheaper and significantly less brittle when used in composites. Glass fibers are therefore used as a reinforcing agent for many polymer products; to form a very strong and relatively lightweight fibre-reinforced polymer (FRP) composite material called glass-reinforced polymer. Glass wool used in the experiment is show in figure 2.2.

Figure 2.2: Glass wool used to prepare Glass fibre

2.3 Epoxy Resin

Epoxies tend to be stronger than other resins, certainly much less brittle on their own than polyester in other words, they have very good flexural strength! They come as two parts which are commonly mixed in ratios ranging 1:1 resin to hardener by weight. They are also much more adhesive (hence their modification as epoxy glues). They are usually more transparent and cleaner looking than many general-purpose polyesters. However, water-clear epoxies specifically for solid casting are not common, presumably due to the high risk of excessive heat build-up. Figure 2.3 shows the epoxy resin used.

Figure 2.3: Epoxy Resin used as a base

2.4 Hardener

A hardener is a component of certain types of mixtures. In some mixtures a hardener is used simply to increase the resilience of the mixture once it sets. In other mixtures a hardener is used as a curing component. A hardener can be either a reactant or a catalyst in the chemical reaction that occurs during the mixing process. Hardeners are almost always necessary to make an epoxy resin useful for its intended purpose. Without a hardener, epoxies do not achieve anywhere near the impressive mechanical and chemical properties that they would with the hardener. Hardener mixed with epoxy resin in 1:1 ratio for reinforcement is shown in figure 2.4

Figure 2.4: Hardener used

III. EXPERIMENTATION AND RESULTS

3.1 Charpy Impact test

High strain-rate test was carried out on the prepared test specimen using charpy impact test machine to determine the amount of energy absorbed by a material during fracture and the following table shows the amount of energy absorbed by carbon fibre reinforced polymer and glass fibre reinforced polymer. Figure 3.1 shows the charpy test machine used. Figure 3.2, 3.3 shows specimen after experimentation.

Table 3.1: Charpy Imapct Test Results

Specimen	Dimension	Energy absorbed
Carbon fibre reinforced polymer	55X10X5.5	6.5 Joule
Glass fibre reinforced polymer	55X10X10	6 Joule

Figure 3.1: Charpy test machine used for specimen testing

Figure 3.2: Carbon FRP after charpy test

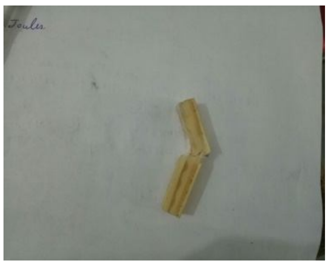

Figure 3.3: Glass FRP after charpy test

3.2 Low Velocity Impact test

Low velocity impact test was carried on the prepared specimen using Drop weight test machine to determine the effect of low velocity impact on carbon fibre reinforced polymer and glass fibre reinforced polymer. Specimen surface were ground flat. 2kg impactor is freely dropped through a guide from 1m height two times and the indentation/ damage is measured. Results are summarized below. Figure 3.4 shows the drop weight test used. Figure 3.5, 3.6 shows the specimen after experimentation.

Specimen	Dimension in mm (ASTM D7136)	Location	Measurement of damage, mm		Damage mode	Observation
			Depth	Max damage diameter		
Glass FRP	150x100x10	1	0.05	14.15	Dent/depression	Cracking observed
		2	0.15	14.07	Dent/depression	Cracking observed
Carbon FRP	150x100x10	1	0.04	6	Dent/depression	No Cracking observed
		2	0.06	9.97	Dent/depression	No Cracking observed

Figure 3.4: Drop weight test used for specimen testing

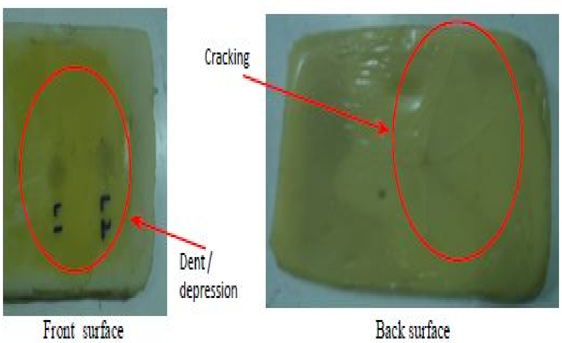

Figure 3.5: Glass FRP after drop weight test

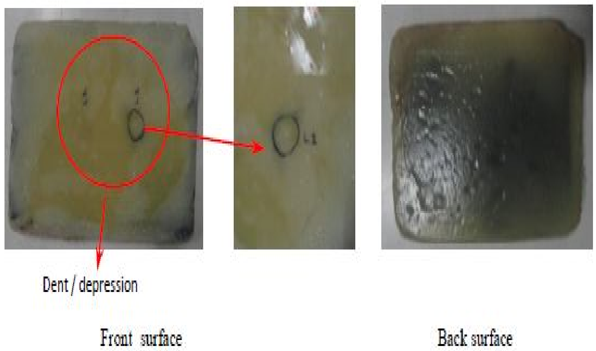

Figure 3.6 : Carbon FRP after drop weight test

Charpy Test and Drop Weight Test were conducted on both of the specimen I.e. CFRP and GFRP.

But among the CFRP and GFRP, Carbon fibre Reinforced Polymer withstood both experiments experiencing some dents whereas Glass Fibre Reinforced Polymer showed a considerate amount of strength but lesser than the CFRP.

IV. CONCLUSION

Most importantly, material properties and the thickness of the polymer influence the impact dynamics. The characteristics of the projectile – including its weight, shape, height are other parameters to be considered. This project includes: an introduction and classification of composites, low-velocity impact testing and energy absorbed at fracture point by carbon fibre reinforced polymer and glass fibre reinforced polymer. The application of composite materials has become increasingly popular, especially in aerospace structures. The advantages of using composites in aircraft structures are; weight reduction, high corrosion resistance and high resistance to damage from fatigue. These factors play a role in reducing the operating costs of the aircraft in the long term, further improving its efficiency.

V. ACKNOWLEDMENT

We had only the idea, but support gave us with the correct direction so that this work can be completed. We are thankful to School of Mech. Engg., REVA University, Bangalore.

REFERENCES

[1] Analysis of low velocity impact behaviour of aramid-linen fibre reinforced composites using Taguchi method by D. IONESI, C. DUMITRAS*, L. CIOBANU, A. VIRCAN *„Gheorghe Asachi" Technical University of Iasi*

[2] Low Velocity and High Velocity Impact Test on Composite Materials by S.N.A. Safri,M.T.H. Sultan, N. Yidris, and F. Mustapha *Aerospace Manufacturing Research Centre, Universiti Putra Malaysia*
[3] An Experimental Study of Low Velocity Impact (LVI) On Fibre Glass Reinforced Polymer (FGRP) by S.N.A. Safri, T.Y. Chan, and M.T.H. Sultan
[4] Low velocity impact analysis on glass fiber reinforced composites with varied volume fractions by Rakesh Reghunath