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STUDY OF MECHANICAL AND WEAR PROPERTIES OF EPOXY AND CARBON POWDER COMPOSITES WITH OR WITHOUT REINFORCEMENT (E-GLASS)

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Abstract— An experimental investigation has been conducted to evaluate the mechanical properties and wear behavior of epoxy composite with different proportions of carbon powder without e glass as reinforcement as a first part of investigation. As a second part of investigation e glass-fiber reinforced in epoxy matrix filled with different proportions of carbon powder were developed.

Keywords— Composite, FRP, E-Glass Fibre, hardness, D-shore, wear test

I. INTRODUCTION

Materials with better properties have high demand to replace existing materials or to meet new requirements. The performance of continuous fiber reinforced polymer matrix composites is well known and adopted. The disadvantages of composites related to matrix dominated properties which limit their wide application and creates the need to develop new generation of composite materials. The adding of filler materials [1-6] to a polymer is a common thing. This improves mechanical and thermal properties, and also reduces the processing cost significantly. More than 50% of all polymers produced are in one or another filled [6] (2011) with inorganic fillers to achieve the desirable properties. Epoxy is used in industries in for coatings, electronics and aerospace applications. Epoxy is the dominant matrix material for light weight polymer– matrix structural composites such as carbon fiber composites.

II. METHODOLOGY

Hand layup technique is used for preparing epoxy/e glass/graphite hybrid composite material. Hand lay-up it is the simplest technique used for composite processing. The infrastructural requirement for this method is also minimal as the processing steps are simple.

The wax is pasted on surface of the mold to avoid the sticking problems. Required amount of E-glass fiber and epoxy is taken three times the weight of e-glass. E-glass are made in

the form of chopped strand mats and placed at the surface of mold after pasting wax.

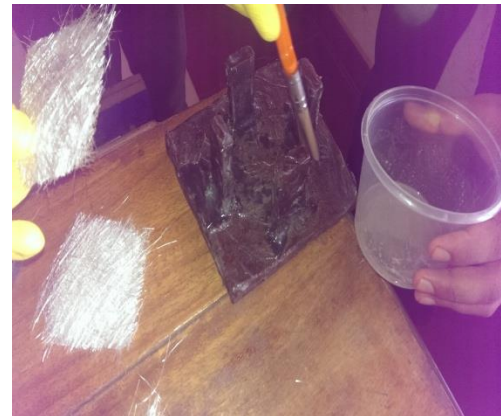


Fig: 1 Quenching with epoxy

Then the general purpose resin (epoxy) is mixed thoroughly with a Hardener hy951 of some % of epoxy) and poured on the surface of layer which is placed already in the mold. The polymer is quenched by using brush and then spread all over the surface uniformly. [17] (2017). Since there is chance of formation of air cavities it is important to quench properly. Then the second layer of mat is placed on the polymer surface and again quenched on the mat-polymer layer So that if any air trapped can be removed. The process is repeated, till the required layers are prepared. After completing this much work, wax is pasted on the inner surface of the top mold plate which is then kept on the stacked layers and the pressure is applied. After curing either at room temperature, mold is opened after six to seven hours and the developed composite part is taken out and further processed. The time of curing depends on type of polymer used for composite processing. This method is mainly suitable for thermosetting polymer based composites. The investment is less compared to other methods The problem in the process is very slow.

III. RESULTS AND DISCUSSION

3.1 Epoxy-Carbon composite material (without E-glass reinforcement)

Table 3.1 Composition of the specimen

Composite	Composition
Plain	Epoxy (90%) +Hardener (10%)
10% carbon	Epoxy (80%)+Hardener (10%)+Carbon(10%)
20% carbon	Epoxy (70%)+Hardener (10%)+Carbon(20%)
30% carbon	Epoxy (60%)+Hardener (10%)+Carbon(30%)

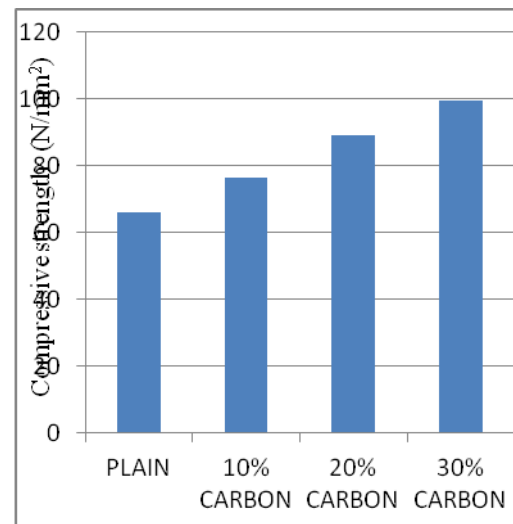


Fig. 2 Variation of compressive strength for different carbon %

3.1.1 Mechanical Properties

3.1.1.1 Hardness test

Table 3.2 Hardness number

Composites	Trial 1	Trial 2	Trial 3	Avg
Plain	47	49	46	47
10% Carbon	47	50	53	50
20% Carbon	58	56	59	58
30% Carbon	67	70	67	68

The higher hardness is exhibited by the 30 wt% carbon filled composite compared to other composition. The increase in carbon content results in an increase in brittleness of the composite.

3.1.1.2 Compression Test

It can be noticed that for the plain Epoxy material the compressive strength value along the specimen is 65.87 N/mm². With the addition of carbon as filler material it is seen that the compressive strength values are increasing. A maximum is seen at 30% carbon filled material.

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3.1.1.3 Wear Test

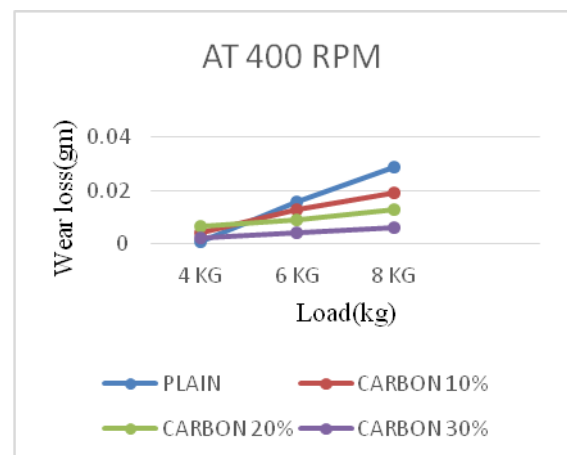


Fig 3. Wear loss at 400 rpm at different load

The fig 3 shows the plot of wear loss and material compositions for 4kg and 8kg loads and under 400 rpm. From the graph it can be see that the plain composition specimen exhibited more material loss at 8kg and the 30% carbon showed less wear loss. And at 4kg the plain composition had

less wear loss due to the factors like the friction and temperature at the contact surface which will be less for the plain specimen. The composite which is filled with 30wt% exhibits less wear loss compared to other composites.

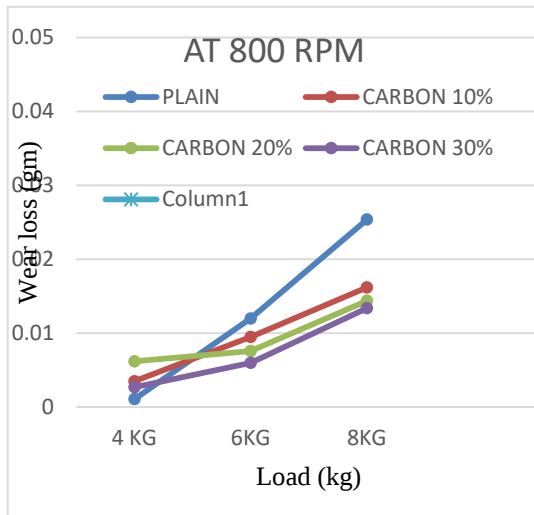


Fig 4 Wear loss at 800 rpm at different load

The fig. 4 shows that carbon filled Epoxy composite exhibits lower wear volume loss than plain Epoxy composite. Moreover, the weight loss of the composites filled with natural fillers depends upon some basic characteristics such as, shape of the filler, size of the filler, and hardness and thermal conductivity of the filler materials.

2.2 E glass-Epoxy-Carbon composite material (With Reinforcement)

Table 3.3 Composition of the specimen

Composites	Compositions
Plain	Epoxy (65wt %) + glass fiber (25wt %) + Hardener (10wt %)
Carbon 10wt%	Epoxy (55wt %) + glass fiber (25wt %) + Hardener (10wt %) + carbon powder (10wt %)
Carbon 20wt%	Epoxy (45wt %) + glass fiber (25wt %) + Hardner (10wt %) +carbon powder (20wt %)
Carbon 30wt%	Epoxy (35wt %) + glass fiber (25wt %) + Hardner (10wt %) +carbon powder (10wt %)

2.2.1 Mechanical Properties

2.2.1.1 Hardness test

Table 3.4 Hardness number

Composites	Trial 1	Trial 2	Trial 3	Avg
Plain	50	51	53	51
10% Carbon	55	60	51	55
20% Carbon	65	72	67	68
30% Carbon	82	81	79	80

The higher hardness is exhibited by the 30 wt% carbon filled composite compared to other micro composites. The table shows that for a 30 wt% increase in carbon content there is 45% increase in hardness. The increase in carbon content results in an increase in brittleness of the composite.

3.2.1.2 Compression Test

It can be noticed that for the plain E-glass/Epoxy material the compressive strength value across the fiber is 23.33N/mm² and along the fiber is 27.7N/mm². With the addition of carbon as filler material it is seen that the compressive strength values are increasing. A maximum is seen at 30% carbon filled material. For 30% carbon filled material the compressive strength across the fiber is 25.667N/mm² and along the fiber is 33.33N/mm².

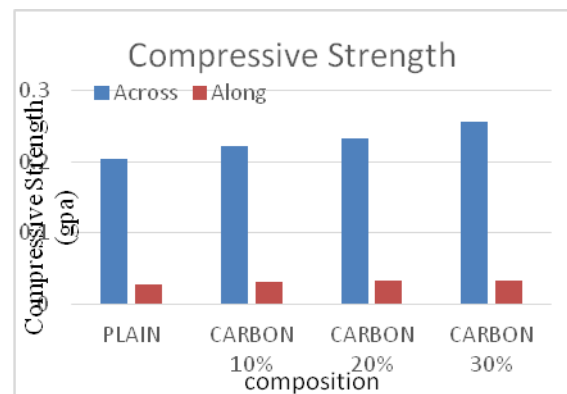
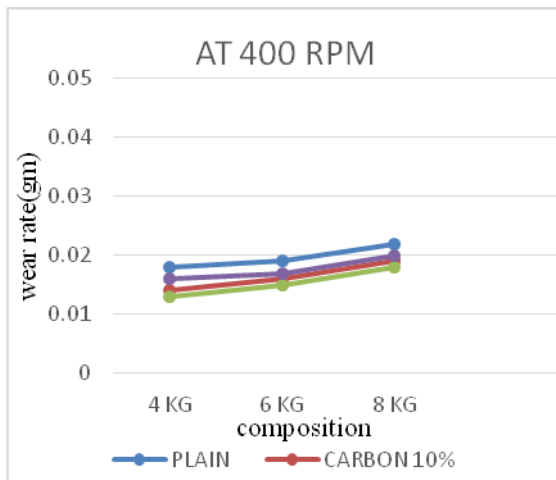
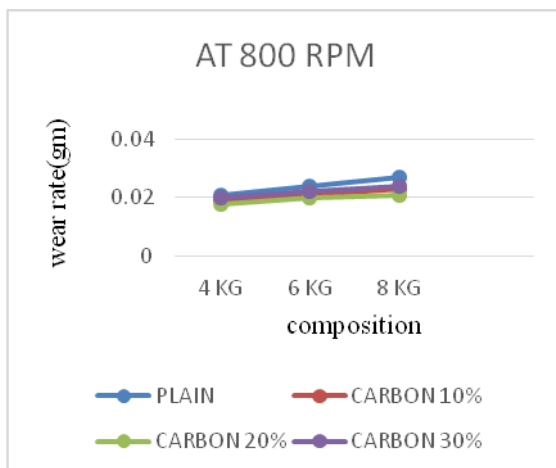


Fig. 5 Compressive strength Vs. Composition

2.2.1.2 Wear Test



Figs 6 wear loss at 400rpm



Figs 7 wear loss at 800rpm

The experimental results reveal that weight loss for all samples increases when there is increase in the normal load applied as we can see in the above fig. The carbon filled E-glass/Epoxy [7] (2006) composite exhibited considerably lower wear volume loss than that of plain E-glass/Epoxy composite. Moreover, the weight loss of the composites filled with natural fillers depends upon some basic characteristics such as, shape of the filler,[8] (2011) size of the filler, and hardness and thermal conductivity of the filler materials.

IV. CONCLUSION

As seen in the investigation of Epoxy-Carbon composite material (without E-glass reinforcement) 30wt% filled carbon has a compressive strength up to 99 N/mm² when compared to the other composite materials and 30wt% carbon filled

composite exhibit very less material wear loss at a load of 40 N and 80N with 400 and 1200 rpm speed respectively.

For Epoxy-Carbon composite material (with E-glass reinforcement). Compared with plain E glass epoxy composite, the hardness of carbon filled e glass epoxy improves, also the compressive strength across the fiber has a good improvement than along the fiber where a slight increment is observed. The higher percentage (30wt%) of carbon content in e glass epoxy composite results to higher compressive strength, hardness and 20wt% carbon content has better wear resistance.

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