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EXPERIMENTAL INVESTIGATION AND ANALYSIS OF MECHANICAL PROPERTIES OF CHOPPED STRAND MAT-E GLASS FIBER POLYSTER RESIN & GRAPHITE POWDER COMPOSITES

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Abstract: Composite materials play a vital role in many industrial applications. Researchers are working on fabrication of new composite materials worldwide to enhance the applicability of thesematerials. In view of this the mechanical performance of the composite material is essential. The objective of the present work is to analyze the effect of silica & graphite powders content on the mechanical behavior of woven E-glass 350gm-Glass fiber reinforced. Five different types of composites are fabricated using 0, 4, 8, 12&16%wt of silica & graphite powders with woven-E glass fiber and polyester isoresin. The polyester isoresin, catalyst and accelerator are mixed in 1:2weight ratio in polyester matrix with silica & graphite.

The aim of the project is to investigate the effect of silica & graphite powders with woven e-glass 350gm for making the composite material stronger and tougher. The investigation is carried out by mixing different weight percentages of the silica & graphite powders with the polyester isoresin and preparing individual samples. After woven-e glass preparation, the materialswere properly mixed using the hand-lay techniques and different specimens were prepared with different compositions of the silica & graphite powders. After all the samples were prepared, mechanical tests were carried out on the samples to ascertain the changes observed due to the composition of silica & graphite powders. The obtained results of various samples specimens werecompared and graphically charted to characterize the new composites material.

Keywords: Woven E-Glass 350gm; Polyester Isoresin; silica & graphite powders; Hand- Lay technique; Catalyst & Accelerator

I. INTRODUCTION

A composite is a structural material that consists of two or more combined constituents that are combined at a macroscopic level and are not soluble in each other. One constituent is calledthe reinforcing phase and the one in which it is embedded is called the matrix. The reinforcing phase material may be in the form of fibers, particles, or flakes. The matrix phase materials are generally continuous. Examples of composite systems include concrete reinforced with steel and epoxy reinforced with graphite fibers, etc.

Historical examples of composites are abundant in the literature. Significant examples include the use of reinforcing mud walls in houses with bamboo shoots, glued laminated wood by Egyptians (1500 B.C.), and laminated metals in forging swords (A.D. 1800).

Fig 1.1: Earliest composite Mud& Clay

1.1 Hand Lay-Up Method

Open mold shaping method in which successive layers of resin and reinforcement aremanually applied to an open mold to build the laminated FRP composite structure

- Labor-intensive
- Finished molding must usually be trimmed with a power
- Finished molding must usually be trimmed with a power saw to size outside edges

Oldest open mold method for FRP laminates, dating to the 1940s when it was first used for boathulls. Hand lay–up, or contact molding, is the oldest and simplest way of making fiberglass– resin composites. Applications are standard wind turbine blades, boats, etc.)

Hand lay-up technique is the oldest method of woven composite manufacturing [30]. The samples are prepared by respecting some steps. First of all, the mold surface is treated by release antiadhesive agent to avoid the sticking of polymer to the surface. Then, a thin plastic sheet is applied at the top and bottom of the mold plate to get a smooth surface of the product. The layers of woven reinforcement are cut to required shapes and placed on the surface of the mold.

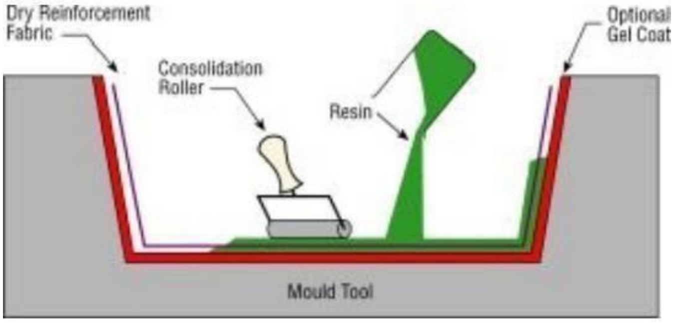

Fig 1.2: Hand Lay-Up Method schematic

1.2 Vacuum-Bag Molding

The vacuum–bag process was developed for making a variety of components, including relatively large parts with complex shapes. Applications are large cruising boats, racecar components, etc.

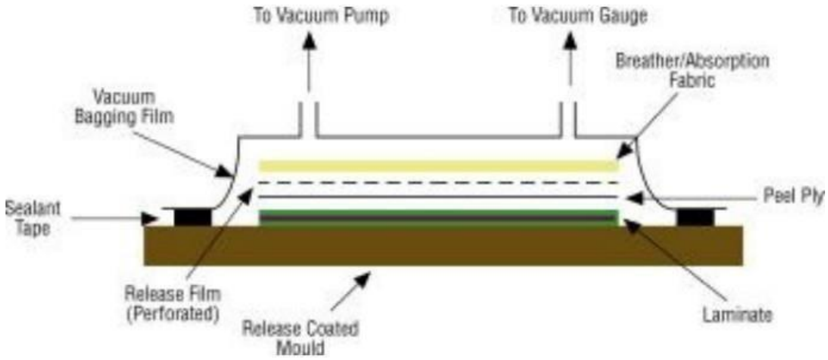

Fig 1.3: vacuum bag mounding

1.3 Summary

From the above literature, the work on Chopped Strand Mat 450 GM-Glass Fiber PolyesterResin with Silica & graphite Powders Composites will give added advantages in development of new composite material; thereby experimental work is initiated and formulated .The report is entitled as –Analysis of Mechanical Properties of Chopped Strand Mat 450 GM-Glass Fiber Polyester Resin with Silica & graphite Powders Composites'. In this, use of the hand layup methodfor fabricating the material at different % of silica & graphite powders like 0%, 5%, 10%, 15%, 20%, are prepared and conducted different mechanical tests for investigation.

Analyzed the influence of Aluminium Oxide filler on Fracture Toughness properties of Chopped Strand Mat (CSM) E-Glass Fibre reinforced Epoxy Resin Matrix. They considered ASTM D5045 standard for the specimen preparation. They have conducted fracture toughness testswith six different compositions of composites. Three samples were tested for each composition ofthe composites. They have fabricated composites by hand-lay method Epoxy resin and hardener was mixed with the weight ratio of 10:1. They have shown the tensile strength for 4wt% of aluminium oxide filled composite is higher compared with 2wt%, 6wt%, 8wt%, 10wt% and neat composite. They concluded that by the addition of small percentage of aluminium oxide filler thereis marginal improvement in fracture toughness of glass fabric reinforced epoxy matrix up.

II. EXPERIMENTAL PROCEDURE

All the samples were prepared by following the same procedure with a few minor changesfor the glass fiber samples. For samples prepared with silica & graphite powders only, the following procedure was used:

The mould was covered with a tile and weights were placed on the tile so as to prevent leakage from the mould. The solution was left to dry in a closed room for 24 hours. To prepare the test specimen, woven e-glass 350gm glass fiber layer is cut to the defined shape as shown in Fig.2.1 and placed in a position on the table. The samples are prepared by woven e-glass 350gm with mixture of polyester isoresin in the ratio 1:2 and mixture with the silica & graphite powders (0,4,8,12&16%) as shown in Fig. 2.2.

The polyester isoresin, catalyst and accelerator are mixed in 1:2 weight ratio in polyester matrix with silica & graphite powders.

Polyester isoresin is applied to the glass fiber using brush since hand-lay method is used and the process which enables the polyester resin to firmly occupy the layer. The next layer of same size and shape is then placed on another layer cut pieces. The same procedure is carried out for six layers till it gets required thickness. This action enables the resin to impregnate the glass mat and dissolve the binder which holds the fibers together. Fig.3.8 shows the hand-lay process for sample specimen preparation. The reinforcement is developed after curing by giving sufficient time for complete drying.

The layers are impregnated in the same order of the previous layer. No air bubbles are presented during the addition of polyester resins. In sequence layer by layer is followed with same orientation of the matrix material with resin and silica & graphite powders (0,4,8,12 and 16%). Also the number of layers prevents the buildup of excessive exothermic property and driedcomposite samples are shown in Fig. 2.3 & Fig 2.4 The heat generation during curing withhigh exothermic temperatures can lead to the cracking, pre-release, distortion or scorching of the laminated and the problem of high exothermic reaction happens ifthere is an uneven thickness of the laminates mostly when thick laminates are used. The cooling is done after complete impregnation of the all the layers.

The delay between the layers is strongly minimized while doing the hand-lay process withbrush. During the process, the laminate can be easily trimmed to the dimensions of the mould andtrim edges can be built into the mould to facilitate this operation. For samples prepared with silica & graphite powders (0%, 4%, 8%, 12%, 16%) with Woolen E-glass fiber 350 GM the above procedure was used and the specimen is marked as - 01 for purely Woolen E-glass fiber 350 GM and polyester resin. The specimen marked as 02, 03, 04 and 05) consist of silica & graphite powders at 4%, 8%, 12%, 16% along with Woven e-glass fiber 350 GM and polyester resin.

The pieces of glass fiber were cut according to the dimensions of the mould. The degassed solution was poured in fractions into the mould. The solution was neatly applied onto the glass fiber sheets before laying them down into the mould. Putty blades were used to remover air bubbles and spread the solution uniformly over the glass fibers.

Before the next process layer by layer the Woven E-glass fiber 350GM of the material is checked for any defect in the lamina such as gaps, holes, irregular orientation of mat etc.. The resins, catalyst, and accelerator should be mixed and applied in the time of 20 to 30 minutes in hand-lay process. After placing the 8 glass fibers in roughly equal intervals, the remaining solution was used to top up the mould and obtain a smooth finish

Fig 2.1: Cut pieces of woven e-glass 350 gm glass fiber.

Fig 2.2: Dried composite material samples.

Fig 2.3: Tensile Testing Machine

Fig 2.4: Tensile test done on the specimens.

III.
3.1 Tensile Testing of Woven E-Glass 350gm Composite

Tensile test was conducted using universal testing machine of 400KN on specimen with different percentages of silica & graphite powders and the values of the tensile load and elongationare shown in table 3.1

Table 3.1 Tensile test performance on different percentages of silica & graphite powders

S.No	Specimenlabel	MaximumLoad (kN)	Load at Break (kN)	UTS (MPa)	Tensile stress atYield (Offset 0.2 %) (MPa)	Load at 2% strain(kN)	Modulus(E-modulus)(GPa)
1	pure	16.46889	16.46	152.49	125.61407	12.27	5.56
2	SI+G4%	19.05605	19.05	176.44	171.29987	16.76	7.59
3	SI+G8%	21.46663	20.80	198.77	198.04285	17.66	7.57
4	SI+G12%	19.22989	19.23	178.05	173.21957	16.71	7.49
5	SI+G 16%	18.50582	18.50	171.35	167.21891	15.97	7.12

3.2 Bending Test of Woven E Glass 350gm Composite.

Table 3.2 Bending test performance on different percentages of silica & graphite powders Maximum stress.

S.NO	MATERIAL	MAXIMUM STRESS
1	pure	307.20
2	Si+4gr	195.96
3	Si+8gr	199.62
4	Si+12 gr	207.25
5	Si+16 gr	199.62

3.3 Hardness Testing of Woven E Glass 350gm Composite.

Hardness test was conducted using Rockwell hardness testing machine on specimen with different percentages of silica & graphite powders and the values of the load and Dia of impressionare shown in table. There are three principal standard test methods for expressing the relationship between hardness and the size of the impression, these being Rockwell, Vickers, and Rockwell. For practicaland calibration reason.

Table 3.3. Rockwell Hardness Test Performance on Different Percentages of Silica &Graphite Powders.

Rockwell Hardness Number Test								
S.No	SpcNo.	Dia of indenter(D	Load in Kg		Dial Readings			RHS
			Minor	Major	1	2	3	
1	E- Glass	2.5	10	150	214	216	214	214.67
2	Si+G4%	2.5	10	150	209	215	212	212
3	Si+G8%	2.5	10	150	216	214	214	214.67
4	Si+G 12%	2.5	10	150	204	215	213	210.67
5	Si+G 16%	2.5	10	150	217	221	225	221

3.4 Impact Charpy Test of Woven E-Glass 350gm:

From the graph we concluded that low percentage of silica & graphite powders is higher at 0% and suddenly decrease and increase is taken place increases8% and suddenly decreases taken next percentage 4%,12%,16% level

Table 3.4 Charphy Test performance on different percentages of silica & graphite powder

Charpy Test					
S.No.	Spec No.	Initial Energy(E1)	Residual Energy(E2)	Absorb Energy(E1-E2)	Impact Strength J/mm^2
1	E-Glass	300	154	146	4.866
2	Si+G=4%	300	210	90	3.00
3	Si+G=8%	300	176	124	4.133
4	Si+G=12%	300	206	94	3.133
5	Si+G=16%	300	204	96	3.2

3.5 Impact Izod Test of Woven E-GLASS 350gm :

Table 3.5 Izod test performance on different percentages of silica & graphite powders

	IzodTest	
S.No.	Specimen no	Impact Strength(J/mm^2)
1	E-Glass	4.8
2	Si+G =4%	5.2
3	Si+G =8%	5.13
4	Si+G =12%	5.06
5	Si+G =16%	5.00

The relation between the Izod and Woolen E-Glass 350gm Specimens with different percentagesof silica & graphite powders

3.6 Conclusions;

The following conclusions are drawn from the present experimental work:

- Woven E-glass 350 gm , polyester isoresin with silica & graphite was successfully prepared as a composite material with five different wt. %, viz 0, 4, 8, 12 & 16%wt.
- The tensile strength with 8 wt% of silica & graphite composite is maximum comparedwith 0, 4, 12 and 16wt%.
- The bending strength with E-glass of silica & graphite composite is maximum comparedwith 0 and remaining decreases 4, 8, 12 and 16 wt%.
- The Rockwell hardness at E-Glass & 16 wt% of silica & graphite composite is maximum ascompared with 0, 4, 8, and 12wt% silica & graphite composite.
- The Charpy impact test at E-Glass of silica & graphite composite is maximum ascompared with 0, and decreases 4,8,12 & 16 wt%.
- The Izod impact test at 4% of silica & graphite composite is maximum as compared with0, 8, 12 & 16 wt%.

3.7 Future Scope of the Work

Image analysis can also be performed to observe the changes in the micro structure ofcomposite, which will be the future scope of the work.

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