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Experimental Investigation of Mechanical Properties of E-glass/ Iso Thalic Polyester with Aluminium Oxide Filler

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***Abstract:*- In the present work, mechanical characterisation of EGlass/Iso Thalic Polyestercomposite by using aluminium oxide as a filler for volume fraction of fibres 15% wt and 25% weight of fibre are prepared. The Aluminium oxide(additive) is added to the resin (iso thalic polyester) in proportion by 5% wt of resin .The fibre length of 6-8mm were used . The mechanical properties of E-glass composite with different fibre fraction are calculated .The impact strength, tensile strength, flexural strength and hardness are investigated .**

***Keywords:*-- E-Glass; Iso-thalic Polyester; Aluminium oxide; Tensile Strength; Flexural Strength; Impact strength; Hardness**

I. INTRODUCTION

The automotive and aeronautical industries have made significant improvement compared to 19 th century due to the emergence of composite materials [1] .Composites materials are also used as a structural materials. The attraction of present day composites materials is that they are lighter, stiffer and stronger than any other material produced ever before. Plastics are lagging behind due to its sufficiently strong, stiff and dimensionally stable for their use in high performance load bearing applications. The composite have distinct features compared to other materials such as low density, high strength and easy formability. Due to certain undesirable properties such as long processing time, high material cost and very less surface finish they fall behind compared to other materials [1]. Glass fibers possesses very high strength, sufficient stiffness and durability. By combining these two materials in specific weight ratio to produce glass reinforced plastics (GRP) with excellent mechanical and temperature resistance properties can be achieved. The properties of composite vary based on the reinforcing fibre, adhesion strength between fibre and matrix and as well as the volumetric fraction of fibre and resin [2-3]. The fibre length and concentration play an important role in properties of composites. Studies have revealed that tensile strength of EGlass fibre with polypropylene increase as the length of fibre increases for an optimum length of 3-6mm and the strength increases upto 40%wt of fibre concentration [4-5]. Impact properties of composites improve as the fibre concentration increases and charpy impact properties and high speed impact properties increases for fibre length upto 6mm [6] Glass fiber isophthalic polyester composites (GFRPC) are materials widely used in applications such as blades for wind turbines, construction structures, marine application. Studies have shown that GFRPC can be used at extreme conditions [7]. The study of properties of GFRPC is quite important due to its diverse field of application. Filler materials are being used now a days in order to improve the properties of composites. Fillers are additives to resins, usually in powder form. They are based on weight percentage of resins. Fillers add bulk to the resin. They can improve composites properties by increasing strength, reducing shrinkage during curing. Too much filler added can reduce the flexural and tensile strength of the composite. Clay as been used as a filler material in glass fibre polyester composite and clay weight percentage of 2% yields good results in increasing the strength, stiffness and with weight percentage of 4% toughness of composite improves[8]. Similar results were seen with chalk powder was used with sisal fibres/glass hybrid fibres, increase in tensile and flexural strength were observed [9]. Aluminium oxide is also used as filler in thermosetting polymer nano composites using polyester as resin, particle size of 15nm of Aluminium were used and considerable improvement in fracture toughness was observed [10]. Buckling load capacity of the glass/epoxy composite also increases as the aluminium oxide is added, buckling load capacity increases by 24.5% due to the the addition of aluminium oxide[11]. Aluminium oxide with size of 30-40nm as filler material has also been used to improve the thermal property of the aluminium oxide- polyster nano composite [12]. The aluminium oxide content as filler material is more, then the mechanical properties like tensile strength and elongation at break values have been reduced, however the reduction is very less as seen in Polyvinyl chloride composite[13]. In this paper E-Glass fibre Iso-thalic polyester composite with

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Aluminium oxide as filler with constant weight percentage of 5% and the weight percentage of fibre is increased by 15% and 25% is manufactured by hand layup method and mechanical properties such as tensile strength, toughness, imapact energy, flexural strength and hardness are investigated.

II. MATERIALS:

E-Glass fibre in the form of woven rovings was purchased and Iso Thalic polyester resin are used. Methyl ethyl ketone peroxide is used as catalyst and cobalt naphthenate as accelerator. Aluminium oxide of nano powder was used as filler.

Experiment: Manufacturing of GFRPC composite with aluminium oxide as filler wasdone by hand layup method. The short fibres of length 6-8mm with fibre concentrations of 15% and 25% by weight percentages were used. Aluminum oxide with weight 5% of resin was added as a filler material. The accelerator of methyl ethyl ketene peroxide 1% by weight and catalyst of cobalt naphthenate of 1% by weight were added to the mixture and were mixed thoroughly.

Testing: Tensile testing of the specimens is carried out in Shimadzu AGX-S plusUniversal Testing Machine .The tests were conducted based on ASTM D638 type 1 test methods used for characterizing tensile properties. Tensile Test were done with cross head speed of 1mm/min. Imapct properties of the specimens were carried out based on ASTM D256 using a Impact Testing Machine AIT-300N. The toughness of the composite were estimated from the area under the stress strain grap. Flexural Strength of the composites were estimated based on ASTM D790. Universal Testing Machine (Shimadzu AGX-S plus) was used to perform the flexural test, a three point bending configuration was selected with a support span length of 80mm and a crosshead speed of 5mm/min. Hardness of the composite were investigated using Rockwell hardness testing machine, F scale is used and steel ball indenter of 1/16inch diameter with a load of 60kgf is applied.

III. RESULTS AND DISCUSSIONS:

The summary of the results of mechanicalproperties of GFRPC with 15% and 25% fibre content with and without aluminium oxide as filler is presented in table 1. The results reveal that the fibre with 25 wt% and aluminium oxide filler 5 wt% of resin exhibited better mechanical properties

A. Tensile Strength:

Tensile strength of the GFRPC composite without aluminium oxideyields value of 42 MPa and 56.07 MPa for 15% and 25% weight of fibre respectively. With aluminium oxide as filler material and keeping the weight percentage as 5% constant. The tensile strength of the GFRPC composite yields 56.07 MPa and 70 MPa respectively for 15% and 25% fibre weight with filler material of 5%. Due to the addition of fibre as well as aluminium oxide there is a considerable improvement in the tensile strength of the composite. Figure 1 shows the tensile test set up in Shimadzu UTM. Figure 2 shows the tensile strength of the composites with filler material and without filler material for 15% and 25% fibre weight. As seen in figure 2 there is continuous improvement in the strength when fibre concentration increases and when filler is added. The maximum loading capacity for GFRPC composite without filler material is around 2800N and 3111N for 15% and 25% fibre weight respectively. However the loading capacity increases gradually for GFRPC composites with 15% and 25% fibre weight with 5% aluminium oxide as filler yields 3364.52N and 4125.60N. From the Stress strain graph we can infer that the yield point is not well defined and the plastic zone deformation is not well defined which clearly shows the brittle characteristics of the composite.

Table1- Mechanical properties of GFRPC with 15% &25% fibre content

Sl. No.	Mechanical Properties of 15% and 25% fibre weight of GFRPC 5%Aluminium oxide as filler					
	Fibre wt%	Tensile strength (Mpa)	Max load in tension (N)	Imapct Energy (J/m)	Hardness (RHF)	Flexural strength (Mpa)
1	15% without filler	42	2800	700	45RHF	12
2	15% with filler	51.86	3364.52	1000	56RHF	16
3	25% without filler	56.07	3111	1100	58RHF	60
4	25% with filler	70	4125.60	2000	69RHF	78

Figure-1 Tensile testspecimen setup

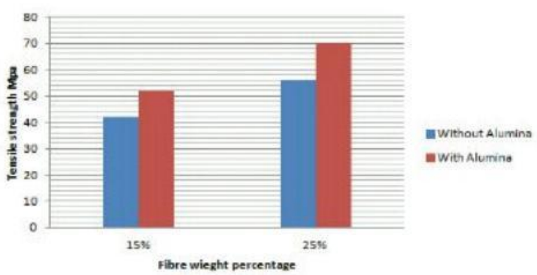

Figure2-Tensile strength of GFRPCcomposite

B. Flexural Strength:

Figure 4 shows the variation of flexural strength in GFRPCcomposite with and without filler.Flexural strength of GFRPC with addition of Aluminium oxide increases and also due to increase in fibre content and. Flexural Strength of 60 MPa is observed in 15% of fibre weight as shown in and a flexural strength of 78 MPa is obtained in 25% of fibre weight composite using aluminium oxide as a filler material. An increase of 30% in flexural strength is observed when GFRPC composite is compared using. Figure 3 shows the impact testing machine with specimen loaded at 80mm span length. The maximum transverse load the composite can take with 15% fibre weight and 5% of aluminium oxide is 498.47 N. The maximum transverse load that a 25% fibre weight composite with 5% aluminium oxide can take is 642.13 N.

Figure 3- Flexural test set up with 80mm span length

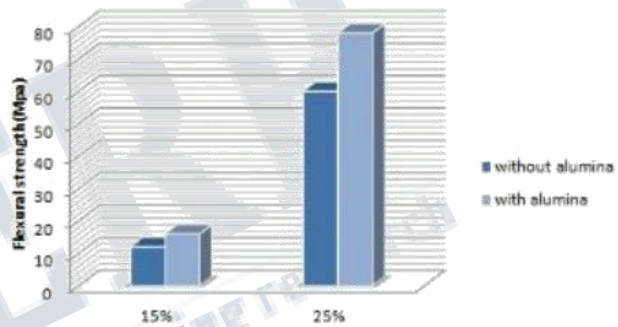

Figure 4 Flexural strength of GFRPC composite

C. Imapct Strength:

The impact strength variation is plotted in the figure 5 which shows theimprovement in strength of the composite.The impact strength of the GFRPC composite with aluminium oxide as a filler material with 15% weight of fibre yields 1000 J/m and without aluminium oxide with 15% of fibre the impact energy was found to be 700 J/m. GFRPC composite with 25% weight of fibre yields 1100 J/m as the impact strength and with filler GFRPC composite with 25% fibre yields 2000 J/m. The impact test is done in charpy testing machine AIT-300N. The Impact strength of the composite increase by 80% when the comparison is made between the composites made up of filler material.

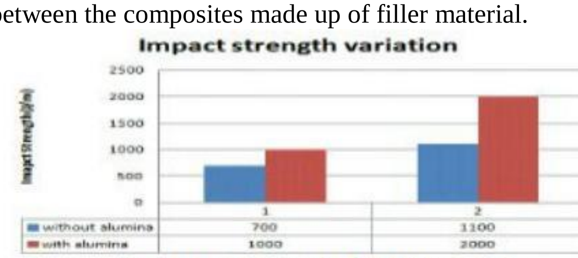

Figure 5- Impact strength of GFRPC composite

D. Hardness:

The hardness of the GFRPC with aluminium oxide as filler and fiber weight as15% was found to be 56RHF and

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without filler material it is found to be 45RHF. Similarly the hardness test was done for 25% fibre weight without the filler materal which was found to be 58RHF and with addition of aluminum oxide it was estimated to be 69RHF. As the weight percentage of fibre increases with addition of aluminum oxide as filler the hardness of the composite increases on observation from figure 6.

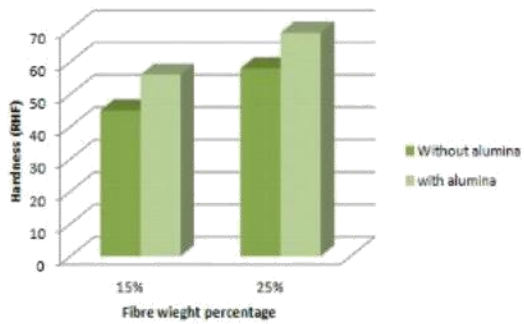

Figure 6- Hardness of GFRPC composite

IV. CONCLUSION:

In this paper the mechanical properties of E-Glass fibre reinforcedpolyester composite with aluminium oxide as filler material have been described. It has been observed that tensile strength of the GFRPC increases with increase in fibre content and also due to addition of alumninium oxide. Similar improvements were seen with flexural, impact strength and also with hardness. Table 1 gives the mechanical properties of GFRPC composite using 15% and 25% fibre weight and also due to the addition of the aluminum oxide powder. Here only 5% of aluminum oxide is added and the results show improvement in the properties. However if the aluminium oxide content is varied then then the properties may increase or decrease. These improved results may allow the application of GFRPC composite having 15% and 25% fibre weight with 5% aluminium oxide as filler material to be used in automotive and construction industry.

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