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Evaluation of Mechanical Properties of GFRP Composites with Fillers

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Abstract: ***The usage of GFRP composites are gradually increasing day by day because of its unique properties over conventional metals. GFRP composite materials are much stronger and contain less weight than the metals which are using in more industries like Automobiles. And it was noticed that the properties of the GFRP composites are decreasing noticeably in certain environmental conditions. So, it is important to improve the quality and mechanical properties of the GFRP composites that they use to odder environmental conditions. From the farmer literature it was observed that adding filler materials to the composite adhesive can enhance the strength and properties of the composite material. In this investigation two filler materials (Znso4, talc) are added to the composites in certain ratios (1%,3%,5% and 7%). And to observe the mechanical properties specimens are placed in water for 30 days, and mechanical tests were performed on the specimens. And It was observed when fillers are added to the matrix of the composite the mechanical properties are increased when it compares to the no filler added composites. Properties are enhanced when the certain ratio of filler were added. Again properties are decreased when the high amount of fillers were added. And high tensile properties were observed when the 3% of filler added. And flexural properties and ILSS properties are enhanced when 1% of filler added.***

Keywords: GFRP, epoxy composites, fillers, talc, zinc sulphate

I. INTRODUCTION

Glass Fiber reinforced composites had been widely used for manufacturing plane and spacecraft structural components because of their unique mechanical and physical properties such as high power and high hardness.[1-5] The matrix, that's continuous and surrounds the alternative section, regularly referred to as reinforcing segment. Epoxy is extensively used in the fabrication of composites; they're a category of thermoset substances of distinctive substances to structural engineers promising to the fact that they offer a completely distinctive balance of chemical and mechanical properties blended with huge processing versatility [9]. Among the reinforcing materials, glass fibers are the most often utilized in structural structures by considering their high strength. Glass epoxy composites are facing important issues after they exposed to environmental conditions like wetness, humidity, high temperatures and Water absorption shows important impact on mechanical properties of the composites [2,6,7]

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The physical and mechanical properties of the composite materials are reducing considerably after they are exposed to wetness and water conditions[8,9]. Because the epoxy polymer is swells, plasticizes and hydrolyzes when it is kept in water for long time[10,11] And it was found that adding of fillers to the matrix will increase the mechanical properties significantly [12].

The fillers are chemically mixed with the polymer matrix of the composites to improve the properties [13]. There are wide range of fillers are available including organic and inorganic fillers types. Inorganic nanofillers area unit additional convenient compared to the organic fillers as a result of its low material and producing value and simply offered commercially [14, 15]. Talc and ZnSo4 were used as fillers to improve the mechanical properties of the epoxy /glass fiber composites. it was observed that fire retardation property of composites are increased and mechanical properties are also increased on addition of the talc as additive[16] The composites with talc as additive showed superior mechanical properties than the pure epoxy composites. It showed three times higher elastic modulus and 2 times bigger hardness.[17] At bigger loadings (ten- forty weight%) it acts as a reinforcing filler, and elevating tensile modulus and stiffness, but decreasing strain-to break and impact properties[18]. when the composites are undergoing for the water absorption for the long time than the mechanical properties are decreasing significantly[19] Swelling reduces the interface between matrix and fiber, it leads to reduce in properties considerably specifically inter laminar shear strength, flexural strength and modulus of elasticity. Hence, the mechanical properties decreased with physical, chemical structure of matrix. Totally, the water absorption ends in reducing the physical, mechanical and thermal properties of FRP composites [20] In this study, the influence of the filler content ratios on the mechanical properties of epoxy composites was studied. For this purpose, tensile test 3-point bending test, and Inter Laminar shear strength tests were performed. Tensile strength, elastic modulus, flexural strength and inter laminar shear strength of the epoxy composites were obtained and evaluated. And the specimens are kept in water for 30 days to study the impact of water absorption on the mechanical properties.

II. EXPERIMENTAL PROCEDURE

A. Materials and Method

In this experimentation, epoxy resin acts as matrix part of the composite. Fillers such as TALC, ZnSo4 were added at a 1%, 3%, 5% and 7 % by weight ratio. L-12 epoxy used and its specifications are given in Table no1.

Table no.1 properties of epoxy resin [lapox L-12]

properties	Values	Units	Test method
appearance	Clear viscous liquid	-	visual
Viscosity at 250c	9,000 - 12,000	m Pas	ASTM D2196
Epoxy value	5.26 - 5.55	Eq/kg	ASTM D1652
Density at 250c	1.1 - 1.2	g/cm3	ISO 1183

Epoxy resin and k-6 hardener was supplied by Atul industries ltd and fillers was supplied by sigma Aldrich. E- Glass fiber used as reinforcement with 600 GSM thicknesses.

III. COMPOSITE PREPARATION

Laminates are prepared using HAND LAY UP method. The filler materials are sonicated in acetone solution for 45 minutes using ultra sonicator for disperse the particles. Than the epoxy resin was preheated o reduce the viscosity and the particles added to the resin according to the decided ratios. Than the mixture is stirred at 2000RPM using mechanical stirrer for 20 minutes. Than the hardener is added to the Mixture and stirred for a minute and laminate was prepared glass fiber as reinforcement. And laminates are allowed for curing for 24hrs.

Fig no 1: preparation of laminates by hand layup method

All the specimens are kept in water for 30 days, before placing in the water the pH value of the water was found out to be 8.1. And the specimens were placed in closed containers for water absorption

Fig no 2: mechanical stirrer

Fig no 3 water absorption

IV. RESULTS AND DISCUSSIONS

A. Tensile Test

Tensile assessments had been carried out on a minimum of three specimens containing equal amount of Talc and znso4 for each percent in keeping with ASTM- D-3039 with the usage of computerized universal testing machine. By adding of fillers the tensile strength elevated for filler loading content to a few weight ratios and then it reduced. A decrease in percentage elongation was located with the increase in filler content material, which suggests that, the brittleness of matrix extended with growth in filler loading. At 3% of filler content the highest tensile properties are obtained. A maximum of 328.96 Mpa was observed. Below figures illustrates the comparison between the results of with % content of filler and tensile strength. And % of elongation from the figures it was observed that the % of elongation decreased as the % of filler content increasing.

Fig no 4: Specimens before and after tensile test

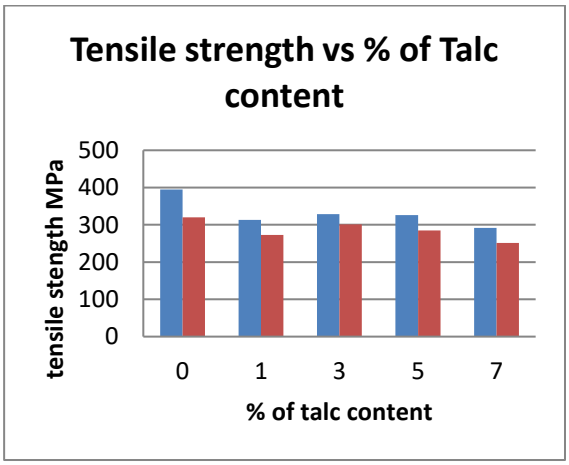

Fig no 5 Tensile strength vs. % of talc content

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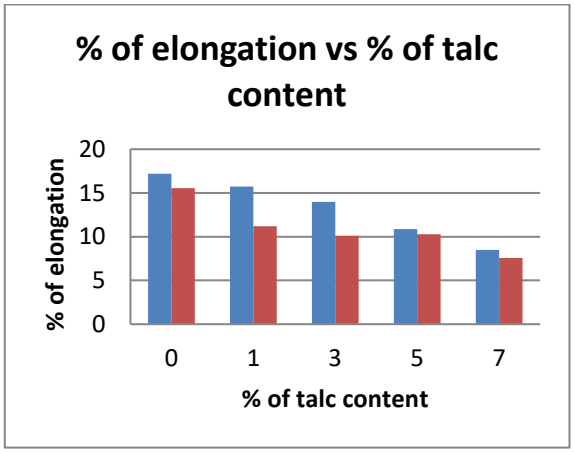

Fig no 6 % of elongation vs. % of talc content

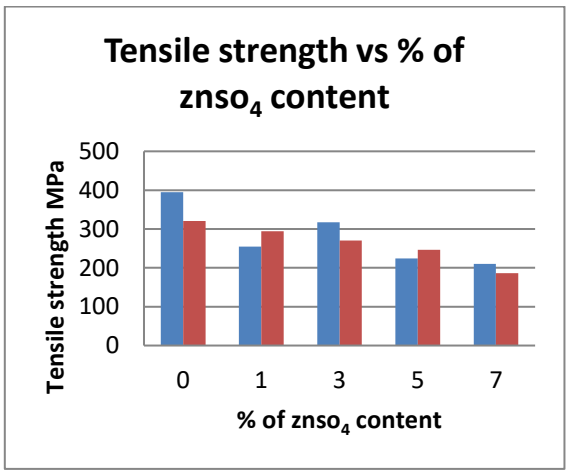

Fig no 7Tensile strength vs. % of znso4 content

(In fig no 7 and fig no 8 blue and red colors indicates without and with water absorption specimen results respectively)

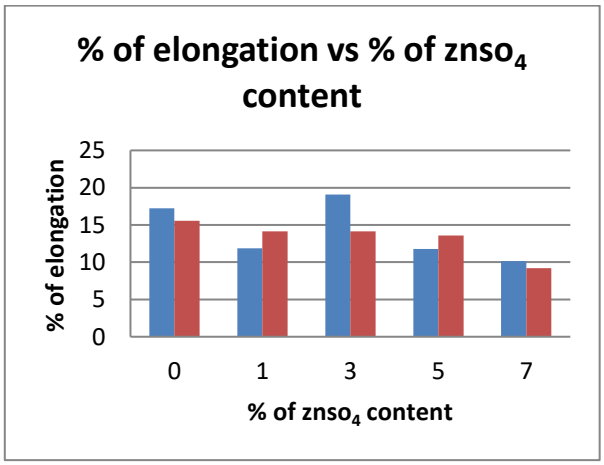

Fig no 8 % of elongation vs. % of znso4 content

B. Flexural Test

Three-point bending test was conducted on a computerized Testing Machine (UTM). ASTM D790 standards were allowed to preparation of samples and testing. 3 samples of each % are underwent the three point bending test. Results are as fallows flexural strength was increased when compared to pure epoxy composites. Maximum results are observed when 1% of filler added. And flexural strength reduced significantly with increasing of the filler content due to void formation in laminates because of more filler content. Flexural properties are significantly decreased after the water absorption for 30 days. Highest flexural strength was observed as 405.819 Mpa and 422.42MPa at 1% of talc and znso4 respectively added to the epoxy. It was higher than that compare to neat epoxy samples that was 392.095Mpa.

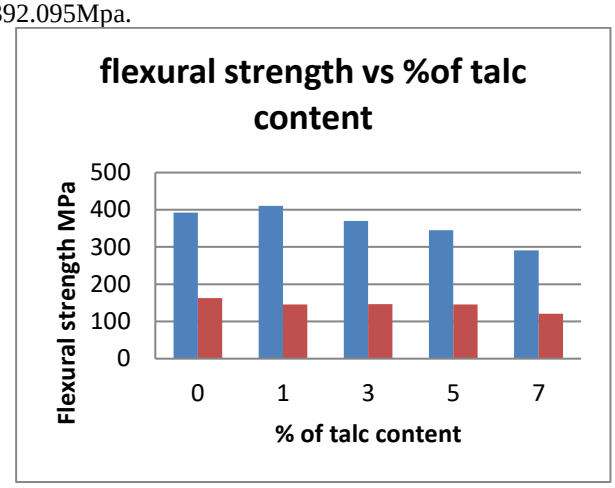

Fig no 9 Flexural strength vs. % of Talc content

(In fig no 9 and fig no 10 blue and red colors indicates without and with water absorption specimen results respectively)

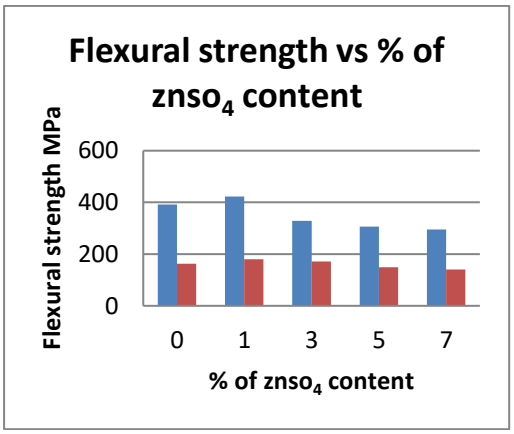

Fig no 10 Flexural strength vs. % of znso4 content

C. ILSS Test

ILSS represents the degree of bonding or adherence between the fiber and matrix of the composites. Normally fillers are added to extend the extent on the interface of fiber and matrix to extend the bonding energy. In the present experimentation 3 specimens from each % of fillers are tested using universal testing machine. ASTM D2234 standards were allowed in the preparation and testing of the specimens. From the figures below it was observed that ILSS strength increased after the fillers added. Highest strength was observed when the 1% of filler added to the epoxy resin. And properties are gradually decreased with the increasing of filler content. After water absorption ILSS strength was decreased by 11%.

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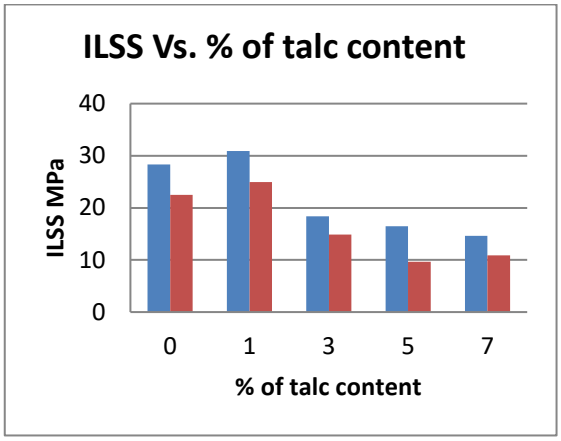

Fig no 11 ILSS VS % of talc content

(In fig no 11 and fig no 12 blue and red colors indicates without and with water absorption specimen results respectively)

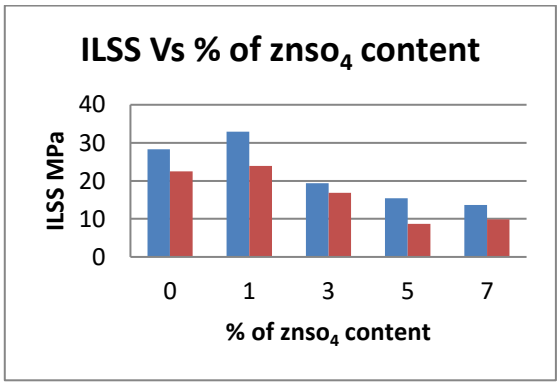

Fig no 12 ILSS of % of $ZnSO_4$ content

V. CONCLUSION

In this present Investigation it was observed that the effect of talc and znso4 filler content on the moisture content and properties of the GFRP composites. The fallowing conclusions may be observed. From the results it was known that moisture content reduced the mechanical strength of composite drastically and tensile strength was decreased and increased when 3% of fillers added. % elongation also increased. Flexural properties are decreased by approximately 50% after the water absorption The higher the filler content the lower the mechanical properties high mechanical properties are observed when 1% and 3% of fillers are added. When the %wt of fillers increased the properties decreased because of the void formation due to fillers.

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