Volume: 5 Issue: X Month of publication: October 2017

DOI: http://doi.org/10.22214/ijraset.2017.10179

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor:6.887
Volume 5 Issue X, October 2017- Available at www.ijraset.com

Investigation of the Effect of Additives on the Impact Test of GFRP Composites

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Abstract: Composites play a vital role in aerospace, land, and goods due to their high toughness and stiffness's, strength to weight ratio. GFRP glass fabric is crucial in obtaining consisting values of composites. In the present investigation to improve impact properties, three different resin matrix systems were used in conjunction with fabric. The epoxy (L-12), epoxy with 10% of silica particles and epoxy with 10% of glass flakes. Test procedure carried out in ASTM-D Specifications D-790, 0-90^o orientations.

Keywords: Composites, GFRP, impact-properties, Epoxy (L-12), 0-90^o

I. INTRODUCTION

Acompositematerialcanbedefinedasamacroscopiccombinationoftwoormoredistinctmaterials,havingarecognizableinterfacebetweenthem. However, because composites are usually used for their structural properties, the definition can be restricted to include only those materials that contain reinforcement such as fibers or particles supportedbya matrix material.

II. LITERATURE SURVEY

Polymer matrix composites are predominantly used for the aerospace industry, but the decreasing price of E-glass is widening the applications of these composites to include the automobile, marine, sports, biomedical, construction, and other industries.An investigation was conducted by Issac M Daniel et.alon failure modes and criteria for their occurrence in composite columns and beams. They found that the initiation of the various failure modes depends on the material properties, geometric dimensions and type of loading[1]. The impact strength depends upon the type of fabric at compressive face and dispersion extent of the fabric[2]. the experimental investigation of inter laminar shear strength as the critical mechanical property of composite constructions of structure elements Placed between two thin glass mat layers where a layer is placed on the glass fabric of the same structure but of different density, with different polyester resin matrices. The significance of the shear strength lies in the fact that for all types of composites it is strongly influenced by factors weakening the interface binds[3].The effect fiber volume fractionon the impact properties of laminated composite constructed of different layers[4].

III.MATERIAL PREPARATION

A. Materials Used to Prepare A Composite Laminate

1) *E glass Fabric:* E-glass fabric is a material consisting of fibers about 5–10 μm in diameter and composed mostly of glass atoms. To produce carbon glass fabric, the glass atoms are bonded together in crystals that are more or less aligned parallel to the long axis of the fiber and they are arranged in '0 and 90 degree directions.
2) *Epoxy Resin.(LY556)*: Epoxy is a thermosetting polymer formed from reaction of an epoxide resin with polyamine hardener. The resin consists of monomers or short chain polymers with an epoxide group at either end. Most common epoxy resins are produced from a reaction between epichlorohydrin and bisphenol
3) *Hardener.(K6)*: The hardener used in Epoxy is polyamine. A polyamine is an organic compound synthetic substances that are important feed stocks for the chemical industry, such as ethylene diamine $H2N\text{-}CH_2\text{-}CH_2\text{-}NH_2$, 1,3-diaminopropane $H_2N\text{-}(CH_2)_3\text{-}NH_2$, and hex methylenediamine $H_2N\text{-}(CH_2)_6\text{-}NH_2$.
4) *Mould Design*: With the help Auto-Cad prepared mould for the experimental procedure.

IV. SPECIMEN PREPARATION

Specimens were prepared from composite laminated plates; the manufacturing process is described under the heading "material preparation". The specimens conform to the requirements lead down in the relevant ASTM specifications listed below.

TABLE I
ASTM SPECIFICATIONS

S.No	Type of test	Additives Added	Relevant ASTM	Number of specimens	Specimen size(mm)
1	Impact	Pure	D-3039	5	67*21*4
2	Impact	Silica	D-3039	5	67*21*4
3	Impact	Glass	D-3039	5	67*21*4

V. TESTING

A. Impact Test

This test method determines the toughness property of polymer matrix composite materials reinforced by high modules fabric. The composite material forms are limited to continuous fabric reinforced composites in which the laminate is balanced and symmetric with respect to the direction. In this test a thin flat strip of material having a constant rectangular cross section67mmx21mmx4mm is mounted in the impact test of the machine and suddenly load is falling from the certain height then the absorbed energy is noted. The Charpy impact test, also known as the Charpy V-notch test, is a standardized high strain-rate test which determines the amount of energy absorbed by a material during fracture. This absorbed energy is a measure of a given material's notch toughness and acts as a tool to study temperature-dependent ductile-brittle transition. It is widely applied in industry, since it is easy to prepare and conduct and results can be obtained quickly and cheaply. A disadvantage is that some results are only comparative

B. Testing

The specimen is placed like simply supported beam having v notch 45 degrees and the pendulum hitting the specimen with certain velocity and it absorb some energy and displaying the remaining reading on the board.Toughness is obtained from the subscration of the total energy to display energy. Impact strength is obtained by the ratio of absorbed energy to area. The height of the arm is 162.2cm and angle is 45 degrees, the weight of arm is 18kgs.

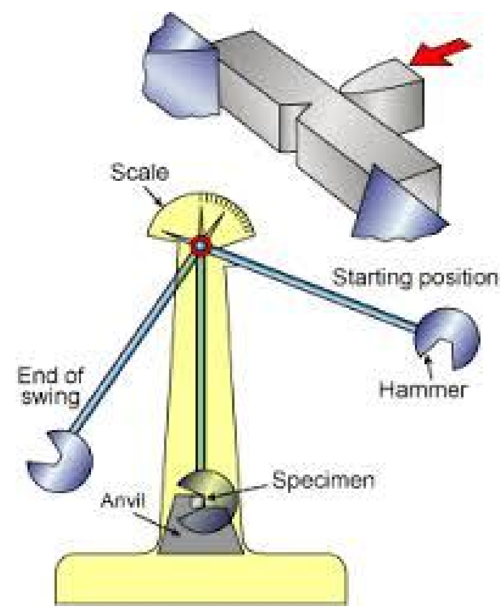

Figure 1: Impact Testing machine

CalculationImpact strength=U/A
Where U=absorbed energy in joules
A = average cross-sectional area,mm^2

VI. RESULTS & CONCLUSIONS

Observed results in respect of specimen derived from Resin#1(R1), Resin#2(R2)and Resin#3(R3) composite plates are placed in

A. Resin#1 Properties: (Pure Laminate)

TABLE II

IMPACT PROPERTIES-PURE

Additives added	Geometry (mm)	Area mm^2	Display reading in joules	Absorbed energy In joules/ mm^2	Impact strength per mm^2
Pure	67×21×4	21×4	94	206	2.45
Pure	67×21×4	21×4	92	208	2.47
Pure	67×21×4	21×4	90	210	2.50
Pure	67×21×4	21×4	95	205	2.44
Pure	67×21×4	21×4	94	206	2.45

B. Resin#2 Properties: (Silica particles added)

TABLE III

IMPACT PROPERTIES- SILICA PARTICLES ADDED

Additives added	Geometry (mm)	Area mm^2	Display reading in joules	Absorbed energy In joules/ mm^2	Impact strength per mm^2
Silica	67×21×4	21×4	82	218	2.59
Silica	67×21×4	21×4	85	215	2.55
Silica	67×21×4	21×4	83	217	2.58
Silica	67×21×4	21×4	87	213	2.53
2.53Silica	67×21×4	21×4	84	216	2.57

C. Resin#3 Properties: (Glass flakes added)

TABLE IV

IMPACT PROPERTIES- GLASS FLAKES ADDED

Additives added	Geometry (mm)	Area mm^2	Display reading in joules	Absorbed energy In joules/ mm^2	Impact strength per mm^2
Glass	67×21×4	21×4	74	226	2.69
Glass	67×21×4	21×4	70	230	2.73
Glass	67×21×4	21×4	75	225	2.67
Glass	67×21×4	21×4	74	226	2.69
Glass	67×21×4	21×4	71	229	2.72

D. Specimen Failure

Figure 2: Pure specimen composite

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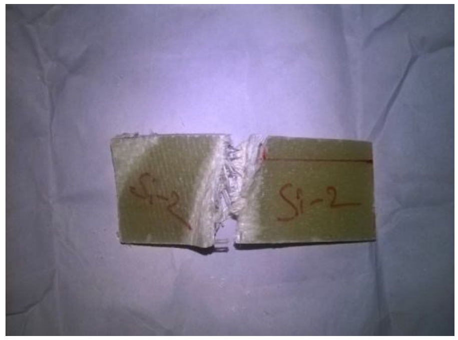

Figure 3: Silica Particles added specimen composite

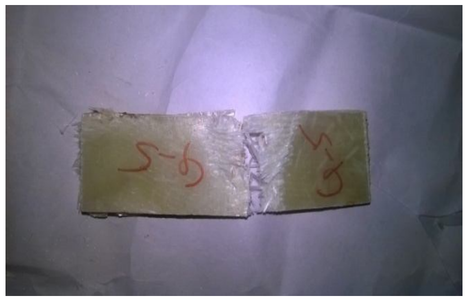

Figure 4: Glass flakes added specimen composite

Full advantage of the enhanced impact properties of the new generation glass fabric can be fully exploited if a judicious choice of matrix system is made.This investigation was aimed at zeroing on an appropriate epoxy resin composition from among a limited number of choices. Among all the resin compositions tried out, Resin#3 (glass)is most preferred one since it has given consistent values of toughness strength at an average in excess of 227.2joules/mm^2

VII. ACKNOWLEDGEMENTS

The authours sincerely thank to Dr.Abid Ali for timely suggestions, AlimPasha.Md who guided our research paper work. We also thank to our principal Dr. M.V. Siva Prasad for providing facilities to complete this paper.

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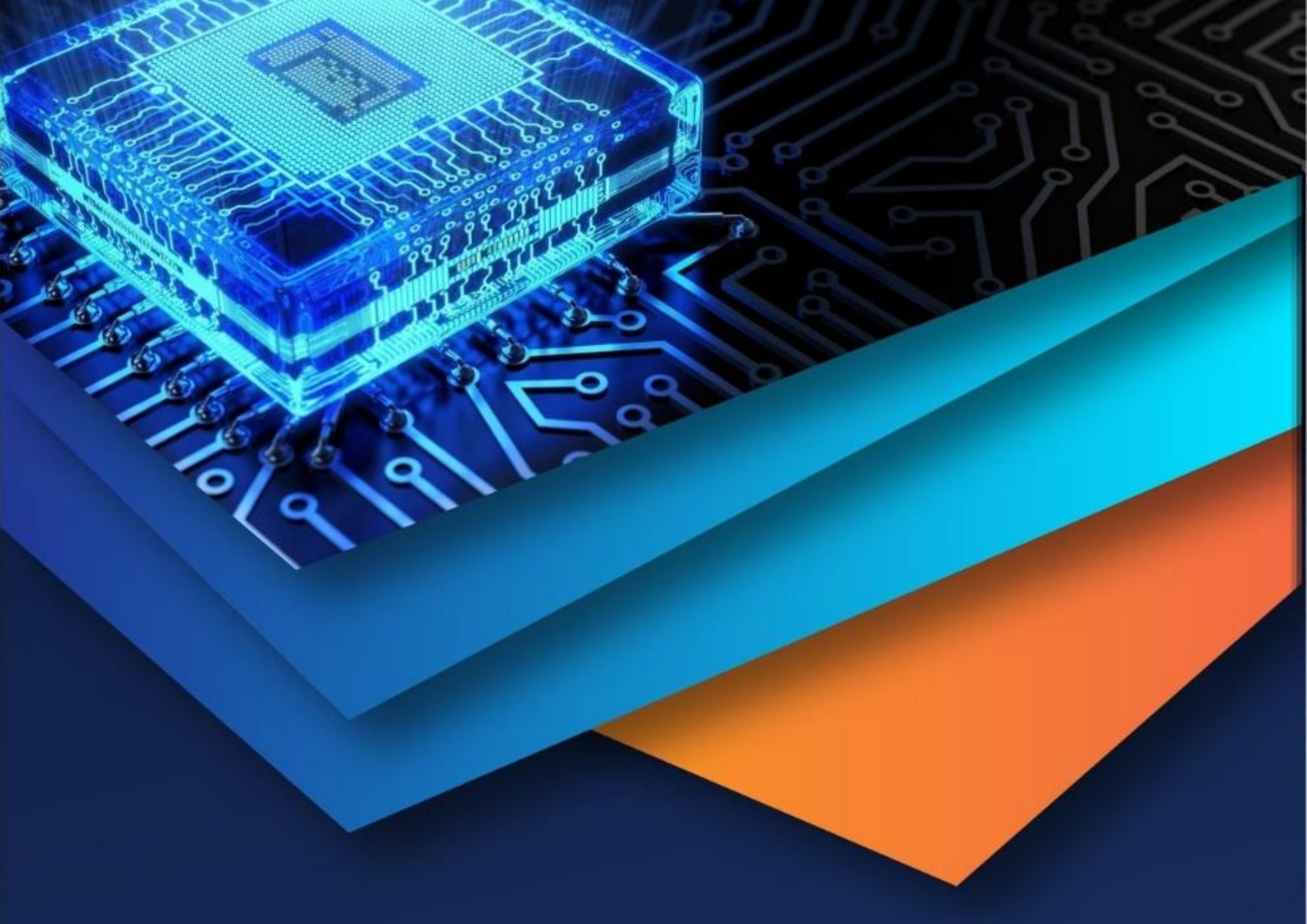

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