Experimental Study on Feasibility of Recycled E-Glass Fibre from Fibre Epoxy Composite

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ABSTRACT

The reusing feasibility of E-glass fibre recycled from fibre glass epoxy composite has been experimentally studied in the present endeavor. To carry out the same, the recycled fiber by thermal processing at 450-500ºC temperature was used. The softened fibre after thermal processing had undergone the gasification process to get removed from the surface pollutants. The cleaned residue fibre is then enforced into the Epoxy matrix with the volumetric ratio of 35:65 respectively. The hand layup method was employed to fabricate the new residue-epoxy composite with the use of an open moulding technique. The resulted sample was undergone various mechanical experimentation for its respective characterization. The obtained experimental results were compared with that of the pure E-glass-epoxy composite. The result declares that, there will be a reduction in strength of glass fibre after thermal processing. But, the same residue fibre has the feasibility to use as additive reinforcements for some applications like concrete, mortars etc

Keyword : *Thermolysis, FRP, gasification, residue fibre, fibre- glass epoxy composite.*

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1. INTRODUCTION

The sustainable elimination of composite material is still the most complicated challenge in the world. The production of composite parts are increasing day by day due to the broad applications of composite materials. The thermoplastics can be reuse by thermolysis process, but recycling of FRP composite has become the global challenge. The FRP composite materials are combination of fibre with matrix with the specified proportion of catalyst. Thus, most of the time these materials get disposed by means of land-filling. This process leads to environmental problem and discomfort to human health. Recycling of thermoset ploymers are complicated work because of the existence of cross-linked chain. These cross-linked materials can no longer remelted or remoulded. So the process of incineration is adopted for eliminate the composite waste in controlled manner.
The most researches and technologies have proposed several methods to recycle the FRP components [1].

1. Thermolysis and gasification process.
2. Fluidized bed thermal process to recover the carbon fibre from original composite material.
3. Chemical depolymerisation by hydrolysis, glycolysis etc. process to recover the organic component.

In this present work an attempt has been made to check the feasibility of the residue fibre remained after the thermal treatment process. Using hand layup technique a specimen was prepared with the reinforcement of residue fibre into epoxy matrix. Certain mechanical characterization was done and comparison was made with the properties of pure E-glass fibre epoxy composite.

2. MATERIAL SELECTION AND SPECIMEN FABRICATION

2.1 Material Selection

The E glass fibre was selected as reinforcement and epoxy – Lapox-12 as resin with the k6 as hardener as the matrix. The E-glass fibre bidirectional woven mat with 200gsm was used. As a binding phase Epoxy resin was chosen. The general reactive group in epoxy is ECHOCH2. The chemical formula of epoxy resin is shown in figure [1]. Table (1) gives the properties of epoxy resin.

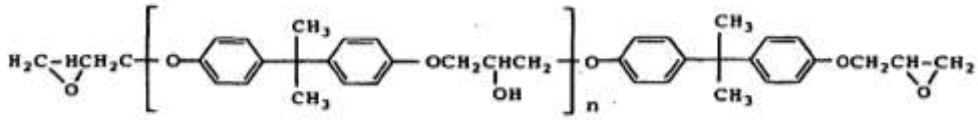

Fig-1. Chemical Formula of Epoxy Resin

Table-1: Properties of Epoxy resin

Material	Trade name and chemical name	Density, kg/m^3	Tensile modulus, GPa	Tensile strength, GPa	Poisson's ratio
Epoxy	LAPOX L-12 Diegycidyl Ether of Biphenyl A (DGEBA)	1162	4	0.1	0.3

The structure and properties of glass fibre plays a important role in fabrication of composite material. The properties of E-glass fibre are reflected in table (2) and Figure (2) illustrates the various materials used for the specimen preparation.

Table-2. Mechanical and Thermal Properties of Glass Fibre

Material	Density	Tensile Strength	Young's Modulus	Melting Temperature	Softening Temperature
E-glass Fibre Bi-directional	2.55 g/cc	2000 MPa	80 GPa	1200˚C	830˚C

Also, the product remained after the thermal treatment process of fibre glass epoxy based component at 450-500 ^{o}C was collected. The residue fibre was then undergone the gasification process to remove the dust and impurities. Figure (3) shows the residue fibre remained after thermal treatment process

Fig-2. Materials for Specimen Preparation

Fig-3: Residue/burnt composite

2.2 Composite Fabrication

The polymer matrix composite are fabricated at room temperature. The major materials required for fabrication were epoxy resin, reinforcement as bidirectional E-glass of 200gsm, k-6 hardener, and wax as releasing agent. The volumetric composition of the resulting composite was selected as 65% of epoxy resin and hardener (10ml for 100ml epoxy resin) with the e glass fibre as reinforcement about 35% according. The mixture was prepared thoroughly and laying process was initiated till the achievement of required thickness. Figure (4) gives the picture of hand layup technique. After completion of laying process the specimen allowed to get cure for about 24 hours and was ejected.

Fig-4. Manual Hand Layup Technique

Fig-5. Composite Samples

The procedure was repeated to fabricate the residue fibre based composite material with the same proportions. Both the specimens were ejected and undergone the finishing and cutting operation to carry the experimentations. Fabricated samples are shown in figure (5).

3. EXPERIMENTAL PROCEDURE

The mechanical properties of composite were evaluated by tensile, compression, hardness, impact and bending test of individual composite specimen. The composite specimens were prepared according to the testing center standards with edge filing and grinding operation.

Tensile test were examined according to standard ASTM D 3039. The tensile and compression tests were carried under computerized universal testing machine FIE 40 UTN-40 with the surrounding atmospheric temperature of about 32^{o}C. Figure (6) and (7) shows the tensile test specimen before and after the experimentation.

Fig-6: Before Tensile Test

Fig-7: After Tensile Test

The compression test was examined according to standards ASTM D 3039. The test specimens were placed in between two plates of UTM machine under the application of gradually increasing load until the material breaks. The compression test specimens are shown in figure (8).

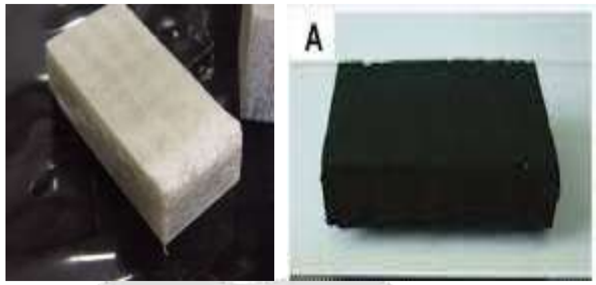

Fig-8: compression Test Specimen

Impact test were examined according to the standard ASTM D 3039. Specimens were tested by charpy v impact type test under FIE(IT-30D) machine having the range of 0-300J. The specimen size was 10*10*55mm with the notch angle of 45 degree. The impact testing specimens are as shown in figure(9) and (10) before and after the test..

Fig-9: Charpy Impact Test Specimen

Fig-10: After Impact Testing

The hardness test was performed using the analog durometer with the respective scale. The hardness had been tested on the surface of specimen, and the scale results were noted down. Figure (11) and (12) shows the Durometer testing and respective samples.

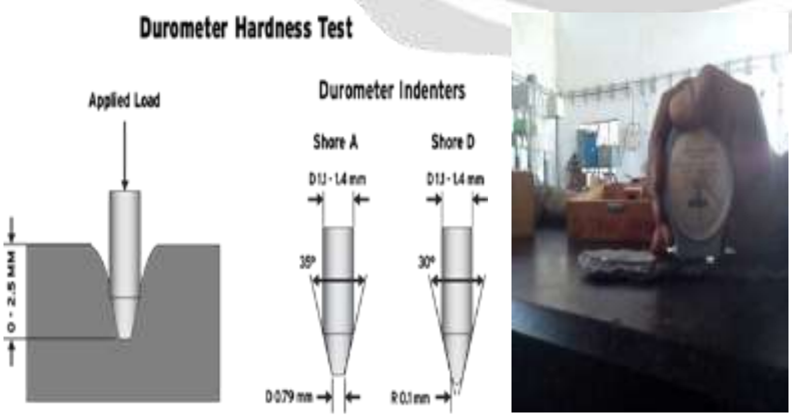

Fig-11: Durometer Presser Foot

Fig-12: Hardness Test Specimen

4. RESULT AND DISCUSSION

The composite specimens are tested for both pure composite and burnt fibre composite material from UTM machine according to ASTM D 3039 standards. The load vs deformation curve as shown in chart (1). For pure epoxy fibre composite material the tensile ultimate load is 29.12kN and the percentage of elongation during the experimentation is 3.22%. the residue specimen were tested for tensile test the load sustain is below 1 kN with 2mm deformation.

The value of compression test for pure composite specimen is 787.2Mpa and the elongation at the peak is 3.16mm. The compression strength for residue composite is 523.6Mpa and elongation at peak is found to be 2.3 mm. from the result it shows that the strength of pure glass fibre is more than the residue glass fibre. Chart (2) shows the comparison of compression strength for both the composite specimens.

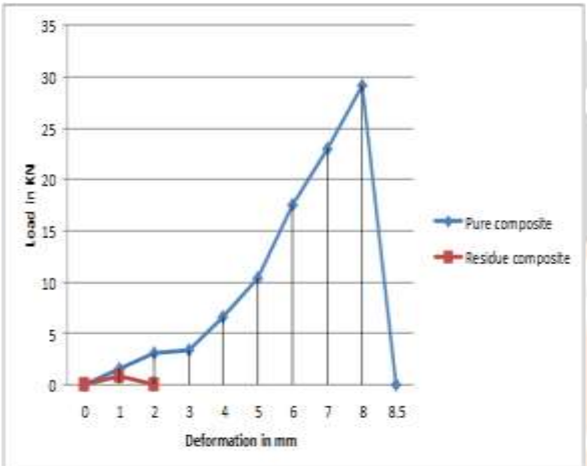

Chart-1: Load vs Deformation Graph for Tensile Test

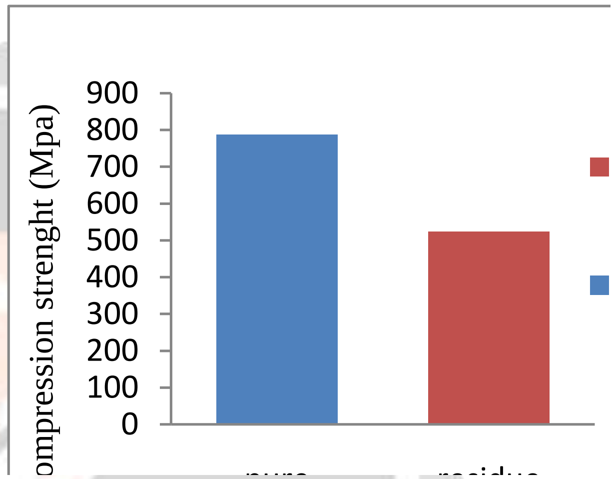

Chart-2. Compression Strength Comparison

Impact value of pure composite was found 4 joules and for residue composite is below 1 joule. It is observed that by decreasing the fibre quantity and strength the absorption capacity of material will be decreasing. Table (3) reflects the impact strength for both composites. The impact strength is given by

Impact strength = E / t
Where E - Energy used to break (J)
t - Thickness in mm

Table-3: Impact Strength results

S N	Type	Energy required to break(J)	Imapct strength(J/mm)
1	Pure E-Glass Composite	4	0.465
2	Residue Composite	1	0.125

Shore D hardness test were examined for pure composite and residue composite on the surface of composite specimen by using the durometer. It has observed that the pure fibre composite is harder than that of the residue composite. Shore-D hardness values has found to be 100for pure composite and is 80 for residue composite. This behavior may be due to the softness of the residual fibre. The Shore-D hardness value is given in table (4).

Table-4: Shore-D Hardness Results

S N	Type	Location	Shore-D Hardness Number
1	Pure Fibre Composite	On surface	100
2	Residue Fibre Composite	On surface	80

4. CONCLUSION

The fibre glass epoxy composite and burnt fibre glass epoxy composite have been fabricated from manual hand layup process. The experimental evaluation has been done according to standard ASTM D 3039. The experimentation reveals that, the pure fibre glass epoxy composite has more strength compare to the burnt/ residue fibre glass epoxy composite. The ductile property of pure fibre glass epoxy composite will get converted to brittle nature after the thermal processing. The result declares that, there will be a reduction in strength of glass fibre after thermal processing. But, the same residue fibre has the feasibility to use as additive reinforcements for some applications like concrete, mortars etc

5. REFERENCE

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