Mechanical Behaviour of E-Glass Epoxy Reinforced with Filler Material (E-Waste) Composite

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***Abstract*: It is desired to produce low cost, high quality, sustainable and environmental friendly materials. It has been found from the researched study that the lower mechanical properties and poor compatibility between polymer matrix and fibers. Composite materials are one of the most favoured solutions to this problem in the field. By combining the stronger properties of traditional materials and eliminating the disadvantages they bear, fiber mats of different orientations are developed, composite materials technology is providing compromising solutions and alternatives to many engineering fields. Problems born from material limitations like heavy weight, structural strength, and thermal resistance are being solved by the composite material alternatives, and many more alternatives are being introduced to readily use engineering applications. E-waste management is one of the difficult tasks in present world. This project deals with development of composites using E-glass, E-waste and Epoxy Resin. Composites with different filler ratio (0٪,5٪,10٪) are developed. Tests were conducted to find the mechanical properties of the composite developed. It has been found that composite with 10٪ filler material has properties better than the others.**

***Keywords*: E-waste, E-glass, Epoxy Resin, Mechanical properties, Filler material.**

1. Introduction

A composite material is made by combining two or more materials to give a unique combination of properties. The above definition is more general and can include metals alloys, plastic co-polymers, minerals, and wood. Fiber-reinforced composite materials differ from the above materials in that the constituent materials are different at the molecular level and are mechanically separable. In bulk form, the constituent materials work together but remain in their original forms. The final properties of composite materials are better than constituent material properties. The concept of composites was not invented by human beings; it is found in nature. An example is wood, which is a composite of cellulose fibers in a matrix of natural glue called lignin. The shell of invertebrates, such as snails and oysters, is an example of a composite. Such shells are stronger and tougher than man-made advanced composites. Scientists have found that the fibers taken from a spider's web are stronger than synthetic fibers. In India, Greece, and other countries, husks or straws mixed with clay have been used to build houses for several hundred years. Mixing husk or sawdust in a clay is an example of a particulate composite and mixing straws in a clay is an example of a short fiber composite. These reinforcements are done to improve performance. The main concept of a composite is that it contains matrix materials. Typically, composite material is formed by reinforcing fibers in a matrix resin. The reinforcements can be fibers, particulates, or whiskers, and the matrix materials can be metals, plastics, or ceramics. The reinforcements can be made from polymers, ceramics, and metals. The fibers can be continuous, long, or short. Composites made with a polymer matrix have become more common and are widely used in various industries.

The composite material, however, generally possesses characteristic properties such as high strength-to-weight ratio, high stiffness-to-weight ratio, high temperature performance, corrosion resistance and hardness, which are not possible to obtain with the individual components.

2. Fabrication of specimens

A. Materials

The fabrication of composite requires reinforcement of E-glass and filler material, resin (Epoxy and polyester), hardener. A thin protective film was laid to prevent final composite from mechanical abrasion. A roller was used to have a uniform distribution of the resin system throughout the film. A roller was used to allow proper binding between the resin mix and the reinforce materials. The various materials involved are

1. Woven roved E glass fiber mat 360 gsm
2. E – waste (filler material)
3. Epoxy resin - LY 556
4. Hardener – ARALDYTE (grade K6)

B. Development of composite

1) Filler powder preparation

Electronic goods which completed its life are selected and parts which cannot be reused are subjected to recycling. Parts are now dumped into E-waste recycling plants where we get the E-waste in the form of powder and the required sized powder is collected using a siever.

2) Specimen preparation

By choosing appropriate amount of E-glass, E-waste and epoxy resin composites are developed accordingly as per ASTM D-638 standards.

3) Steps for Development of Composite

1. Wash the flat surface/slab (granite slab) carefully with warm water and soft soap to remove any dust, grease, finger marks, etc.
2. Dry the mould thoroughly.
3. Apply the acetone solution carefully with a piece of sponge or foam rubber, the solution must be allowed to dry completely.
4. The slab is treated with a release agent to prevent sticking. Epoxy or polyester is weighed out and the correct quantity of 10% hardener for epoxy and stirred in. Brush is the most suitable.
5. Epoxy resin and powder of E- waste is added in reference to the percentages required.
6. The weight of fabrics is determined, in accordance with the quantity of resin to be used and is decided in such a way that the final plate is made up of 40% resin and 50% reinforcement by weight.
7. The first resin coat is applied on the release film as per the size of the fabric with the help of brush.
8. The first layer of fabric is placed over the 2 resin coat in and Care must be taken to ensure an even coverage of resin, free from air bubbles.
9. Immediately after the first layer of fabric has been applied a compression roller is used to compress the mat and squeeze air bubbles and excess resin from the laminate. This technique appreciably improves the strength of the moulding by increasing its density and reducing its porosity on the inside surface, so it is important that the roller are used firmly and evenly across the entire surface.
10. Successive layers of laminate are now applied to the mould until the lay-up is complete. Each layer is compression rolled as described above. The number of layers required will depend on the type of moulding and the structural stresses it will need to withstand in use.
11. After the final resin coat is applied, the lay- up is covered by another release film. The mould is closed by placing the weight/ top slab.
12. After the model is completed it is then compressed used a hydraulic press where it exerts weight upto 100-150 kg.
13. It is then kept for 12 hrs in order to have a perfect finish.

3. Experimental method

A. Tensile test

Tensile testing, also known as tension testing, is a fundamental materials science test in which a sample is subjected to a controlled tension until failure. The results from the test are commonly used to select a material for an application, for quality control, and to predict how a material will react under other types of forces.

B. Hardness test

Hardness is the resistance of a material to localized deformation. The term can apply to deformation from indentation, scratching, cutting or bending. Hardness measurements are widely used for the quality control of materials.

C. Flexure/Bend test

1) Results of Tensile Test

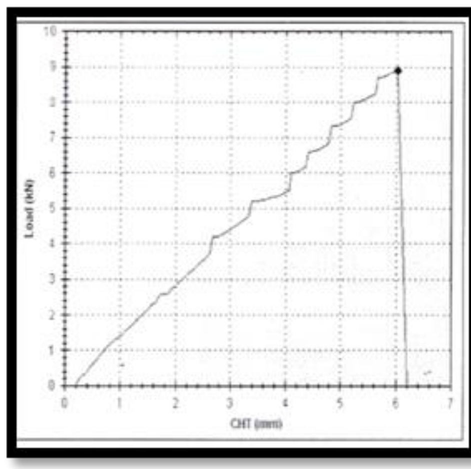

Fig. 1. For 0% filler material

Input data
Specimen width: 22.52 mm
Specimen thickness: 3.37 mm
Specimen area: 75.89 mm^2

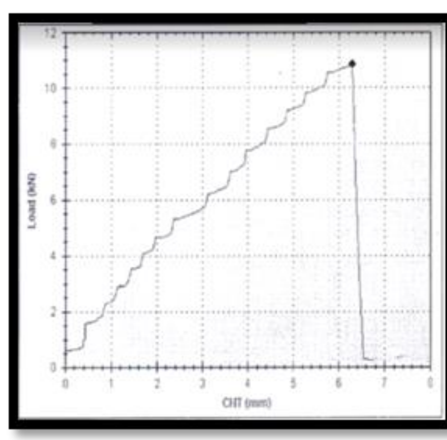

Fig. 2. For 5% filler material

Input data
Specimen width: 19.09 mm
Specimen thickness: 3.47 mm
Specimen area: 66.24 mm^2

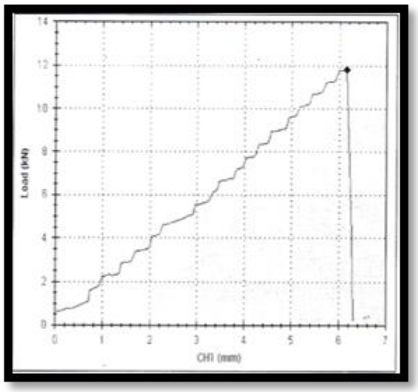

Fig. 3. For 10٪ filler material

Input data
Specimen width: 22.47 mm
Specimen thickness: 3.13 mm
Specimen area: 70.33 mm^2

Table 1
Output data table

٪ of filler material	Load at peak (kN)	Elongation (mm)	Tensile strength (N/mm^2)
0٪	10.840	6.290	142.834
5٪	8.900	6.020	134.355
10٪	11.800	6.170	167.778

2) Results of Hardness Test

Table 2
Table title comes here

Sample information	R-Scale
0٪ filler material	79
5٪ filler material	79.5
10٪ filler material	80

3) Flexural/Bend Test Results

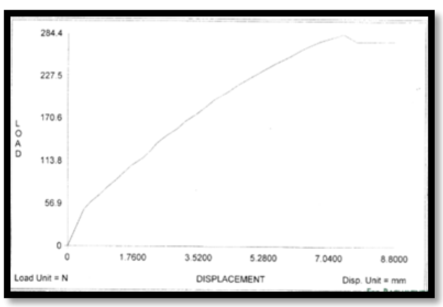

Fig. 4. For 0٪ filler material

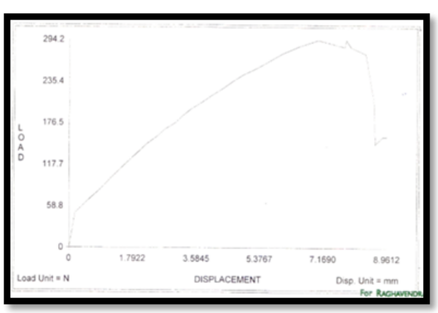

Fig. 5. For 5٪ filler material

Table 3
Overall conclusion of the comparison

S. No.	Mechanical properties	0٪	5٪	10٪
01	Max load (N)	284.4	294.2	343.2
02	Deflection of max load (mm)	7.425	7.009	7.281
03	Ultimate tensile stress (Mpa)	7.405	6.878	8.137
04	Young's modulus (Mpa)	50.37	46.16	46.49
05	strain at break	0.147	0.149	0.175

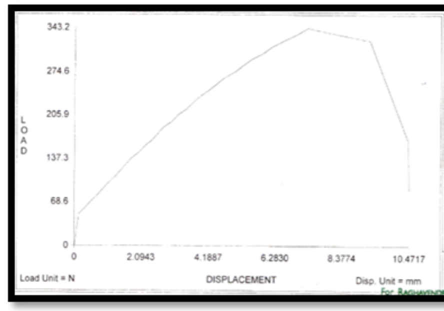

Fig. 6. For 10٪ filler material

4. Conclusion

The e-waste reinforced polymer composite were prepared in the laboratory at different filler ratios of 0%, 5%, 10%. The main outcome of the present investigation are as follows:

- Effect of filler content in glass fibre composites seems to play significant role in assessing material behaviour under tensile loading conditions.
- From the experimental results it can be concluded that e-waste can be recycled successfully by using it has filler in polymer composites.
- As the ratio of filler material increases the flexural strength. The composite containing 10% filler shows higher tensile strength.

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