INVESTIGATION OF MECHANICAL PROPERTIES OF EPOXY BASED COMPOSITES REINFORCED WITH CHICKEN FEATHER

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ABSTRACT

Composites are combinations of two or more than two materials in which one of the materials, is reinforcing phase (fibers, sheets or particles) and the other is matrix phase (polymer, metal or ceramic). Composite materials are usually classified by type of reinforcement such as polymer composites, cement and metal- matrix composites. Polymer matrix composites are mostly commercially produced composites in which resin is used as matrix with different reinforcing materialsPolymer (resin) is classified in two types thermoplastics (polyethylene (PE), polypropylene (PP), polyether ether ketone (PEEK), polyvinyl chloride (PVC), polystyrene (PS), polyolefin etc.) and thermosets (epoxy, polyester, and phenol–formaldehyde resin, etc.) which reinforces different type of fibre like natural (plant, animal, mineral) and man-made fiber for different application.

KEY WORD:- *Chicken feather***,** *Epoxy resin (Araldite LY 556), Hardener (araldite) HY 951*

1.INTRODUCTION

Composites are combinations of two or more than two materials in which one of the materials, is reinforcing phase (fibers, sheets or particles) and the other is matrix phase (polymer, metal or ceramic). Composite materials are usually classified by type of reinforcement such as polymer composites, cement and metal- matrix composites (Chemical and Materials Engineering Department, home Page 2011; About.com, home page, 2011). Polymer matrix composites are mostly commercially produced composites in which resin is used as matrix with different reinforcing materials. Polymer (resin) is classified in two types thermoplastics (polyethylene (PE), polypropylene (PP), polyether ether ketone (PEEK), polyvinyl chloride (PVC), polystyrene (PS), polyolefin etc.) and thermosets (epoxy, polyester, and phenol–formaldehyde resin, etc.) which reinforces different type of fibre like natural (plant, animal, mineral) and man-made fiber for different application. In metal matrix composites, metal is one of important part of element and other part may be metal, ceramic or organic compounds. Cement matrix composites are made up of cement and with aggregate and basically used in building applications. Due to increase in population, natural resources are being exploited substantially as an alternative to synthetic materials. Due to this, the utilization of natural fibers for the reinforcement of the composites has received increasing attention. Natural fibers have many remarkable advantages over synthetic fibers. Nowadays, various types of natural fibers (Taj et al., 2007) have been investigated for use in composites including flax, hemp, jute straw, wood, rice husk, wheat, barley, oats, rye, cane (sugar and bamboo), grass, reeds, kenaf, ramie, oil palm, sisal, coir, water hyacinth, pennywort, kapok, paper mulberry, banana fiber, pineapple leaf fiber and papyrus. Natural fibers are largely divided into three categories depending on their origin: Mineral based, Plant based, and Animal based. In general, a mineral based composite is asbestos and is only a naturally occurring mineral fiber (silicate based mineral). In 2006, 2.3 million tons of asbestos were mined worldwide. Russia was the largest producer with about 40.2% world share followed by China (19.9%), Kazakhstan (13.0%), Canada (10.3%), and Brazil (9.9%) (Wikipedia, home page,2010). The main properties of asbestos fibers are their thermal, electrical, and sound insulation; inflammability; matrix reinforcement (cement, plastic, and resins), adsorption capacity, wear and friction properties (friction materials), brake linings and chemical inertness (except in acids). Asbestos fibers are often mixed with cement or woven into fabric or mats/ sheets (Britannica home page, 2011; Wright, 2005). Plant-based natural fibers are lingo-cellulosic in nature composed of cellulose, hemicellulose, and lignin, whereas animal based fibers are of proteins, e.g., silk and wool. Natural fiber-reinforced polymer composites have attracted more and more research interests owing to their potential as an alternative for synthetic fiber composites such as glass or carbon fiber composites (Bledzki & Gassan, 1999). Natural fiber composites possess the advantages such as easy availability, renewability of raw materials, low cost, light weight and high specific strength, and stiffness. It is expected that in the near future biodegradable polymers will replace synthetic polymers, at least in some specific applications where a short life of the product will be more desirable. Natural polymers are considered suitable to replace synthetic ones in some specific applications where a long span life is not required. Natural fiber thermoplastic composites are relatively new family of composite materials. In such composites, a natural fiber/filler (such as kenaf fiber, wood fiber, hemp, sisal etc.) is mixed with a thermoplastic (e.g., polyethylene, polypropylene, PVC etc.) to produce the composite. In the last few years, thermoplastics as well as thermoset based natural fiber composites (NFCs) have experienced a tremendous growth in the auto industry due to environmentally friendliness, renewability of these fibers, good sound abatement capability, and improved fuel efficiency resulted from the reduced weight of the components. These composite materials have received much commercial success in the semi-structural as well as structural applications. For example, interior parts such as door trim panels from natural fiber polypropylene (PP) and exterior parts such as engine and transmission covers from natural fiber-polyester resins are already in use in auto industry. Advantages of thermoplastic NFC over thermoset-based NFC include the greater design freedom as they are suitable for injection molding and extrusion processing in addition to the recycling possibilities.

3.MATERIALS & METHODS

This chapter details the materials used and methodologies adopted during the sample preparation, fabrication, mechanical testing and characterization of the composites.

3.1 Raw materials

Raw materials are used in the experimental works are,

Chicken feather

Epoxy resin

Hardener

3.1Chicken Feather

Refer details of chicken feather in introduction (Sec 2.0)

3.2 Epoxy resin

Epoxy resin Epoxy resin (Araldite LY 556) having the following outstanding properties has been used. Epoxy LY 556, chemically belonging to the 'epoxide' family is used as the matrix material. Fig 3.1 shows the raw materials used for making composites. Its common name is Bisphenol A Diglycidyl Ether. Outstanding adhesion to different materials

i. Abundant strength, toughness resistance
ii. Outstanding resistance to chemical attack and to moisture
iii. Brilliant mechanical and electrical properties.
iv. Odorless, tasteless and completely nontoxic.
v. Insignificant shrinkage.

3.3 Hardener

In the present work Hardener (araldite) HY 951 is used. This has a viscosity of 10-20 poise at 250C. The hardener with IUPAC name NN0-bis (2-aminoethylethane-1, 2-diamin) used with the epoxy has the designation HY-951. The epoxy resin and the hardener were supplied by Ciba Geigy India Ltd. Resin and hardeners are mixed in a ratio of 10:1 by weight as recommended. Density of the epoxy resin system is 1.1 g/cc.

4.PREPARATION

The composite fiber is prepared by both hand lay-up technique and compression molding machine. The chicken feather fiber which is taken as reinforcement in this study is collected from local poultry. The chicken feathers are cleaned with a polar solvent, like ethanol and dried. The quills were removed and short fibers (5-10 mm length, having aspect ratio of $\geq$ 3000) are selected.

Molds with dimensions of 140 x 70 × 5 mm3 were prepared for composite fabrication. For different volume fraction of fibers, and calculated amount of epoxy resin and hardener (ratio of 10:1 by weight) was thoroughly mixed in a jar. Mixing of chicken feather with epoxy is done by using stirring machine at room temperature. Figure 3.2-3.6 illustrates the mold used to construct the composite. For quick and easy removal of composite, mold release sheet was put over the glass plate and a mold release spray was applied at the inner surface of the mold. After keeping the mold on a ply board a thin layer of the mixture was poured. Then the fiber lamina was distributed on the mixture. Then again resin was applied over the fiber laminate and the procedure was repeated to get the desired thickness. The remainder of the mixture was then poured into the mold. Care was taken to avoid formation of air bubbles. Pressure was then applied from the top and the mold was allowed to preserve at room temperature for 18 hrs. Samples with the size of 300 x 300 x 3 mm sizes are prepared for 0% and 5 % weight of chicken feather with epoxy resins and also both treated and non- treated chicken feathers are considered. During application of pressure some amount of mixture of epoxy and hardener squeezes out. Care has been taken to consider this loss during manufacturing of composite sheets. After 18 hrs the samples were taken out of the mold.

4.1 Hand lay-up

Prior to the composite manufacturing, the CFF samples were conditioned for 48 hours at the fiber linear density values were determined in accordance with ASTM and the tensile properties of the fiber were determined in accordance with ASTM. The composites were fabricated with different fiber loadings (10%, 20% and 30%). Initially, polyester resin was mixed in hardener using a mixer in a bowl after the phenyl ester, polyester, resin was also prepared separately. The matrix materials were prepared in a portion of 70% of resin matrix and 30% of hardener by volume. Then, the fibers were spread into mold and covered with the matrix. The composites were manufactured by using a hand lay-up technique with size mold of 210 mm length x 210 mm width x 10 mm thickness. The composites were kept for 24 hours at room temperature and subsequently put in an oven for 8 hours at 80°C for curing. The control and the CFF reinforced composites were evaluated in accordance with ASTM size.

5.TESTING OF MECHANICAL PROPERTIES

Mechanical properties of composites were evaluated by tensile and hardness measurements. Tensile, impact tests were carried out using Universal testing machine, impact machine and hardness testing.

5.1 Density measurement

From the table 5.1 it is observed that the void fraction percentage of composite increases as the percentage of reinforcement increases still the void content is very less so it shows that the composite fabrication is done properly. Figure 4.1 is drawn between the measured densities of the composites and weight fraction of the composite.

Table.5.1 Density of different samples

Feather Type	Fiber Content (%)	Measured Density (g/cm^3)	Theoretical Density (g/cm^3)	% Difference
Treated feather	0	1.082	1.12	2.70

	2.5	1.089	1.1156	2.384
	5	1.0991	1.1196	1.831
Un-Treated feather	0	1.0835	1.113	2.563
	2.5	1.091	1.1156	2.205
	5	1.0921	1.1196	2.456

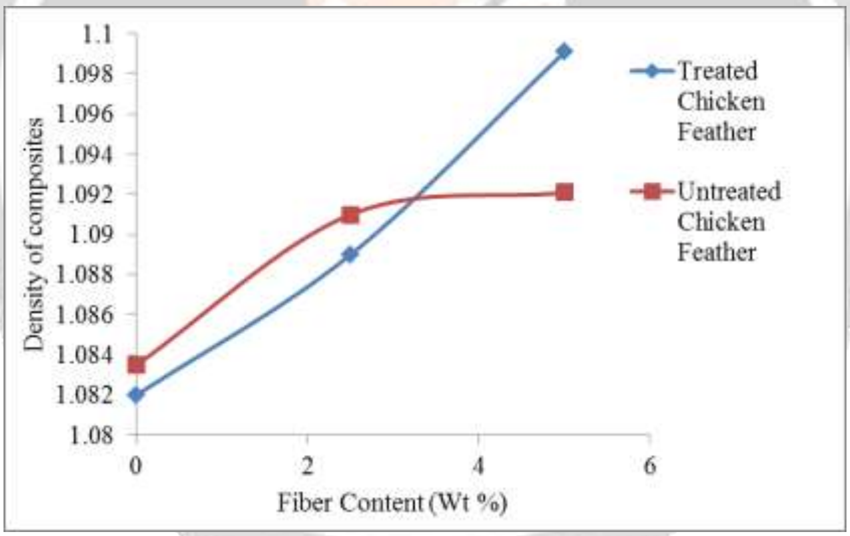

Fig.5.1 Variation of density of composites

5.2 Tensile Measurements:

Fig. 5.2 and Table 5.2 shows, addition of Chicken feather to the epoxy composite induced a rise in tensile strength from 7 MPa to 13 MPa. When Chicken feather content was 2.5 vol.%, the maximum strength was 13 MPa. An increase of Chicken feather content beyond this amount caused a reduction in tensile strength to 7.5 MPa.

Table.5.2 Density of different samples

Feather	Fiber content (%)	Tensile strength (Mpa)
Treated feather	0	8.05
	2.5	10.25

	5	14.5
	Fiber content (%)	Tensile strength (Mpa)
Untreated feather		
	0	7.3
	2.5	9.56
	5	12.23

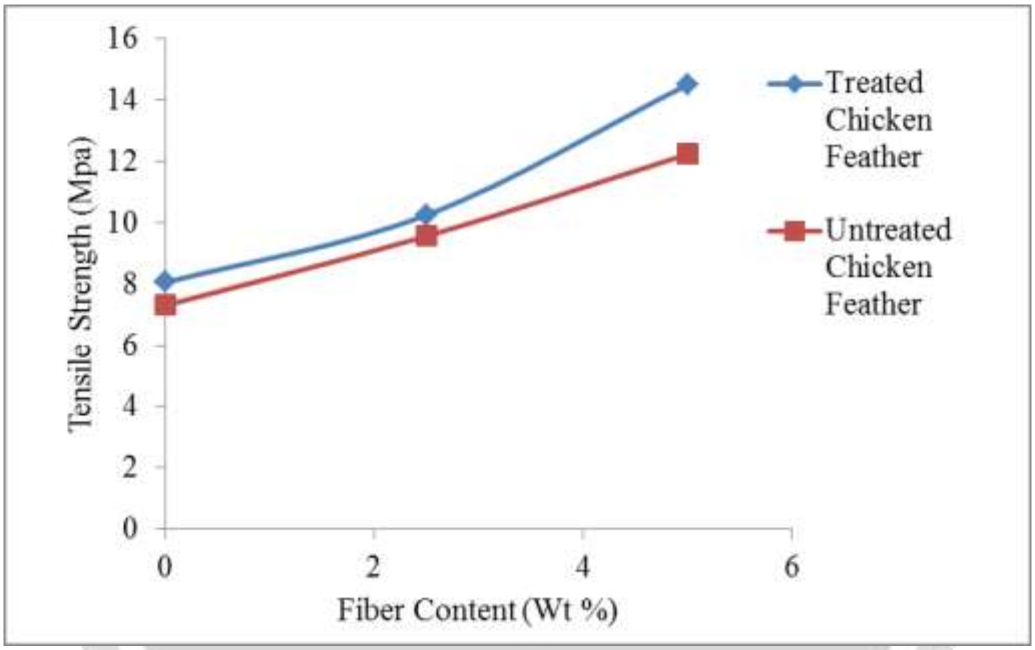

Fig.5.2 Variation of tensile strength of composites

To further analyze the influence of chicken feather addition to the mechanical properties of the composite, the following variables were assessed, both independently and in terms of their mutual interaction: structure, oxidative treatment and concentration level.

6.CONCLUSION

In all the testing of properties of material as compression and tension on samples of uni and bi-directional glass fiber reinforced epoxy resin based polymer composites, following points has been completing. Unidirectional oriented glass fiber epoxy composites have large value of all the properties such as Ultimate force, yield force, Compressive strength, Tensile strength, elongation etc. in tensile as well as compression test.

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