Effect of rubber powder as filler on Glass fiber reinforced epoxy composites

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ABSTRACT

This paper describes the fabrication and mechanical characterization of polymer composites consisting of glass fibre as reinforcement, epoxy resin as a matrix and micronized rubber powder (MRP) as filler materials. Composites with three different composition of filler material (5%,10% , 15%) are fabricated by simple hand layup technique. The newly fabricated composites were characterized for their mechanical properties such as Tensile strength, Flexural strength & Hardness as per ASTM standards to find the influence of rubber powder as filler material on mechanical properties of glass reinforced epoxy composites.

KEYWORDS: Flexural strength, Micronized rubber powder, Epoxy composites, Fibre reinforcements.

1. INTRODUCTION

Composite materials can be formed by combining two or more materials with different properties together at macroscopic level to get enhanced properties as a combined effect. Fiber reinforced composites have been widely used for manufacturing aircraft and spacecraft structural parts because of their particular mechanical and physical properties such as high specific strength and high specific stiffness. Another relevant application for fiber reinforced polymeric composites (especially glass fiber reinforced plastics) is in the electronic industry, in which they are employed for producing printed circuit boards[1].

Composite materials are consists of two phases: the matrix phase & reinforcing phase. Epoxy resins, which are thermo set material are widely used as matrix in many fiber reinforced composites; particular interest to structural engineers owing to the fact that they provide a unique balance of chemical and mechanical properties combined with wide processing versatility. Reinforcing materials generally withstand maximum load and serve the desirable properties. Within reinforcing materials, glass fibers are the most frequently used in structural constructions because of their specific strength properties. The present study focuses on mechanical property of GFRP laminated composites with filler material Rubber powder and evaluation of materials property[1].

Ajit et al. [2] studied the effect of fly ash filled with epoxy composite exposed to moisture to determine the inter laminar shear strength and inter laminar fracture toughness and found due to addition of particulate reinforcements in the polymer matrix reported to improve the Interlaminar shear strength and Interlaminar fracture toughness. The particulate reinforcement precipitator fly ash(25-45μm) was added in the epoxy matrix by mechanical mixing up to 10wt%. the effect of fly ash reinforcement on the mechanical properties and Interlaminar Fracture toughness were studied before and after exposure to aqueous fog in a salt fog chamber at 45°C. In unexposed condition Mode I interlaminar fracture toughness of epoxy glass fibre laminate composite improved by addition of fly ash reinforcement 10% (by weight) by 49.43% and when it was subjected t aqueous fog for 10 days the interlaminar fracture toughness improved 58.42%. due to exposure of moisture the brittleness of the matrix decreased.

Bhadrabasol et al.[3] have studied the mechanical and two body abrasive wear behaviour of alumina filled glass fibre reinforced epoxy composites. Alumina filled G-E composites containing 0,5,7.5 and 10 wt% were prepared using hand layup technique followed by compression molding. From the experimental investigation, it was found that the filler material Al2o3 improved the tensile strength and tensile modulus of composites. adding of alumina into G-E composites reduced the specific wear rate. It is found that by adding 10% of filler gave very less wear loss.

2. MATERIAL SELECTION

2.1 Matrix Material(Epoxy Resin & Hardener)

Epoxy resin(Araldite LY556) blended with Hardener (HY951) is widely used matrix material in industrial application due to its high strength and good mechanical adhesive characteristics. It is also a solvent and has capacity to retain its chemical stability over wide range of temperature. The density of the epoxy ranges from 1.15 - 1.20 g/cm^3 at 25°C and viscosity ranges from 10000-12000 Mpa S.

2.2 Glass Fiber

Glass fibre is a material consisting of numerous extremely fine fibres of glass fibre has roughly comparable mechanical properties to other fibres such as polymers and carbon fibre. Although not as strong or as rigid as carbon fibre, it is much cheaper and significantly less brittle when used in composites. Glass fibres are therefore used as a reinforcing agent for many polymer products the most common types of glass fibre used in fibreglass is E-glass, which is alumino-borosilicate glass with less than 1% w/w alkali oxides, mainly used for glass-reinforced plastics.

2.3 Rubber Powder

Micronized rubber powder (MRP) is classified as fine, dry, powdered elastomeric crumb rubber in which a significant proportion of particles are less than 100 μm and free of foreign particulates (metal, fibre, etc.). MRP particle size distributions typically range from 180 μm to 10 μm. MRP is typically made from vulcanized elastomeric material, most often from end-of-life tire material, but can also be produced from post-industrial nitrile rubber, ethylene propylene diene monomer (EPDM), butyl and natural rubber compounds.

Fig.1 E Glass Fibre Mat

Fig.2 MRP-Micronized Rubber Powder

3.Fabrication Process

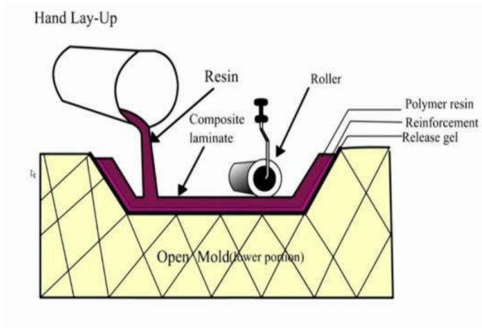

Fig.3 Hand layup Technique

Hand lay-up technique is the simplest method of composite processing. The infrastructural requirement for this method is also minimal. The processing steps are quite simple. First of all, a release gel is sprayed on the mould surface to avoid the sticking of polymer to the surface. Thin plastic sheets are used at the top and bottom of the mould plate to get good surface finish of the product. Reinforcement in the form of woven mats or chopped strand mats is cut as per the mould size and placed at the surface of mould after Perspex sheet. Then thermosetting polymer in liquid form is mixed thoroughly in suitable proportion with a prescribed hardener (curing agent) and poured onto the surface of mat already placed in the mould. The polymer is uniformly spread with the help of brush. Second layer of mat is then placed on the polymer surface and a roller is moved with a mild pressure on the mat-polymer layer to remove any air trapped as well as the excess polymer present. The process is repeated for each layer of polymer and mat, till the required layers are stacked. After placing the plastic sheet, release gel is sprayed on the inner surface of the top mould plate which is then kept on the stacked layers and the pressure is applied. After curing either at room temperature or at some specific temperature, mould is opened and the developed composite part is taken out and further processed. The schematic of hand lay-up is shown in figure 1. The time of curing depends on type of polymer used for composite processing. For example, for epoxy based system, normal curing time at room temperature is 24-48 hours. This method is mainly suitable for thermosetting polymer based composites. Hand lay-up method finds application in many areas like aircraft components, automotive parts, boat hulls, Dias board, deck etc.,

Table:1 Composition details of composite laminate

Composition	Name	Epoxy wt %	Fiber wt %	Filler wt %
Glass-Epoxy with 5% MRP	A	45	50	5
Glass-Epoxy with 10% MRP	B	40	50	10
Glass-Epoxy with 15% MRP	C	35	50	15

4. SPECIMEN PREPARATION

The specimens for the mechanical characterisation are prepared as per the following ASTM standards.

Table:2 Specimen preparation as per ASTM Standards

Test specimens	ASTM	size
Tensile test specimens	ASTM-D638	150x20x3mm
Flexural test specimens	ASTM E-399	125x12x3mm
Hardness test specimens	ASTM-D785	25x25x3mm

5.TESTING AND GRAPHS

The tests test to find mechanical properties were conducted using calibrated Universal Testing Machine(UTM). Different tests were such as tensile test, flexural(three point bending) tests were carried on UTM and hardness test carried on digital rock well hardness tester.

5.1 Tensile test

The tensile test was conducted for varying percentage of rubber powder (5%, 10%, and 15%) as a filler material on E-glass fiber as a Reinforcement and Epoxy resin as a matrix. The specimens were prepared as per ASTM D-638 and tested to find tensile strength.

Table:3 Specimen preparation as per ASTM Standards

Composition	Cross section area (mm^2)	Peak Load (N)	Ultimate Tensile Strength(MPa)	Young's Modulus(MPa)
5% Rubber Powder filled Glass Epoxy	52.266	9708.50	185.753	783.763
10% Rubber Powder filled Glass Epoxy	55.448	10260.60	191.541	886.767
15% Rubber Powder filled with Epoxy	51.486	8394.50	163.044	862.668

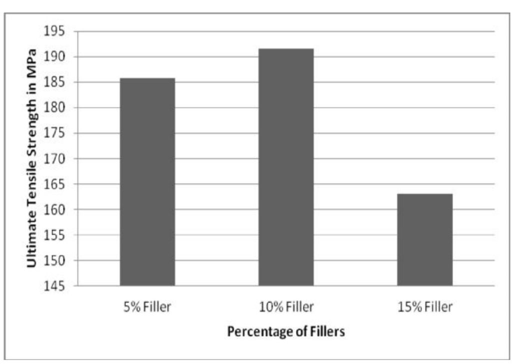

Fig 4. Ultimate Tensile Strength (MPa)

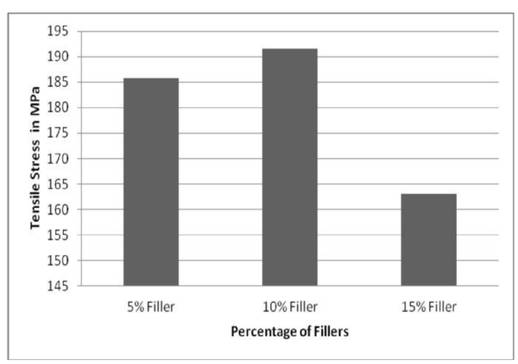

Fig 5.Tensile Stress in MPa

5.2 Flexural test

The Flexural test was conducted for varying percentage of rubber powder (5%, 10%, and 15%) as a filler material on E-glass fiber as a Reinforcement and Epoxy resin as a matrix. The specimens were prepared as per ASTM E-399 and tested for tested to find flexural strength.

Table:4 Specimen preparation as per ASTM Standards

Composition	Load F (N)	Flexural Strength (MPa)
5% Rubber Powder filled Glass epoxy	304.00	288.85
10% Rubber Powder filled Glass epoxy	245.20	186.13
15% Rubber Powder filled Glass epoxy	186.30	212.43

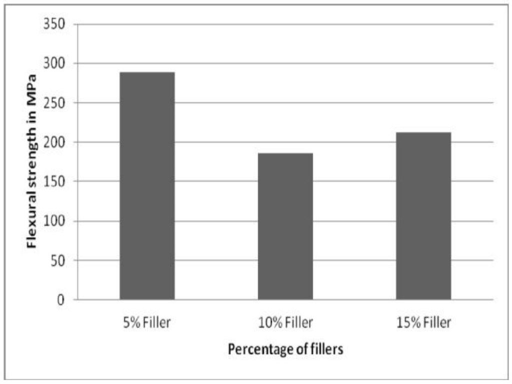

Fig 6.Flexural Strength (MPa)

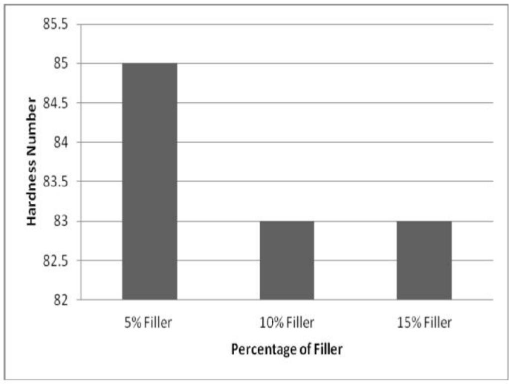

Fig 7. Hardness Number

5.2 Hardness test

The Hardness test was conducted for varying percentage of rubber powder (5%, 10%, and 15%) as a filler material on E-glass fiber as a Reinforcement and Epoxy resin as a matrix. Following are the graphs and tabulation of the results.

Table:5 Different Compositions of Composite materials

Composition	Hardness Number
5% Rubber Powder filled Epoxy	85
10% Rubber Powder filled Epoxy	83
15% Rubber Powder filled Epoxy	83

6. CONCLUSIONS

The specimens were tested for Tensile, Flexural strength and Hardness at Raghavendra Spectro metallurgical laboratory.

- The laminate of composite was developed by using hand layup technique. The hybrid composite using E-glass and epoxy resin was developed for 5%, 10% and 15% filler material. The effects of combination of the fibers were investigated. The experiments are carried out to understand the variations in mechanical properties by varying percentage of filler material. Tensile, Flexural and Hardness tests were conducted for different percentage of filler material.

- The tensile strength is more at 10% of filler material. Elongation is more at 10% of filler material compared to 5% and 15% of filler material.
- The flexural strength is more at 5% filler material.
- The hardness is more in 5% of filler material.

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