CHARACTERIZATION OF EPOXY/POLYESTER BASED COMPOSITES

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Abstract— Polymer glass fiber reinforced composites plays a vital role in day to day life. The aim of this research Article is processing of Epoxy and polyester based composites reinforced with Glass Fiber and filled with the natural filler**Arabic Gum Tree Coal Powder** (A.C.P) which is prepared by carbonization of Arabic Gum Tree Stem. Manual hand layup process is adopted for preparation of composite with 2.5wt%, 5wt% and 7.5wt% of A.C.P. with Glass fiber of 40 wt% reinforced in Epoxy/Polyester resins by varying their compositions with respect to the composition of the filler material. After the preparation of composites with the compositions, specimen were prepared as per ASTM Standards for Mechanical characterizations. Tensile Strength, Flexural Strength, ILSS, Impact Strength and Hardness were determined.

Index Terms— Epoxy/polyester composites,A.C.P, Tensile Strength, Flexural Strength, ILSS, Impact Strength, Hardness.

I. INTRODUCTION

Polymer composite with fiber-reinforced materials is of two main categories normally referred to as particle reinforced materials and continuous fiber reinforced materials. Fiber used for advanced composite materials were glass fiber, cotton fiber with high strength in humid environment but degrade under elevated temperature [1-2]. Glass fiber is the typical reinforcing material for thermoset matrices for various structural applications. Woven fabric reinforced epoxy composites are well known for their high ratios of strength and stiffness to weight in orthotropic direction. These attractive characteristics of the composites have resulted in numerous applications of the materials in areas where high performance and light weight of structures are essential [3]. Saroja Devi [4], and Ramakrishna [5] have researched the mechanical properties of fly ash-filled general-purpose unsaturated polyester resin. Wong and Truss [6] reported the effect of fly ash addition and the effect of coupling agent on the tensile and impact properties of polypropylene (PP). Gowdaa and Naidu [7] studied the mechanical properties of woven jute fabric-reinforced polyester resin composites.

II. METHODOLOGY

The objective of this work is to fabricate the composites by using simple hand-layup technique. From the prepared compositesthe specimens are cut as per ASTM Standards for mechanical characterization of composites. Composites designation and experimental values are tabulated in table-1&2.

Table-1: Designation and Composition of Composites

Designation of composite	Composition
Ce1	57.5 wt%Epoxy+40 wt%G.F+2.5 wt% A.C.P
Ce2	55 wt% Epoxy+ 40 wt% G.F+ 5 wt% A.C.P
Ce3	52.5 wt%Epoxy+40 wt%G.F+7.5 wt% A.C.P
Ce0	60 wt% Epoxy+ 40 wt %G.F
Cp1	57.5 wt%P+40 wt%G.F+2.5 wt% A.C.P
Cp2	55 wt% P+ 40 wt% G.F+ 5 wt% A.C.P
Cp3	52.5 wt%P+40 wt%G.F+7.5 wt% A.C.P
Cp0	60 wt% P+ 40 wt %G.F

Material Test Details

Tensile Strength and Tensile Modulus

As per ASTM –D-638-III the dog bone type specimen with end tabs is used for tensile test. On TUE-C-200, 2013/50 machine tensile test was performed. From tensile strength we have to find out the tensile modulus using the formula

$E=\sigma * l/\delta l$

Where, σ = tensile strengthδl = Elongation l= length of the specimen

Flexural and Inter Laminar Shear Strength

By using three point bend test on universal testing machine TUE-C-200, 2013/50 for the specimen of size as per ASTM D-790-2003, we can determine the flexural strength and ILSS.

The ILSS equation is

$$ILSS = 3P/4bd$$

And the flexural strength equation is

$$\text{Flexural strength} = 3PL/2bd^2$$

Where, P= maximum load applied on the specimen b = width of the specimen d=thickness of the specimen L=span of the specimen

Impact strength:

On Impact testing machine FIT 300(EN), 2008/105(1) as per ASTM D-256 impact test was done. The values of different specimens are recorded from the dial indicator of impact testing machine.

Hardness

By using shore hardness tester, hardness of the specimen were found for the specimens as per ASTM D 2240 -2003.

II. RESULTS AND DISCUSSIONS

Table: 2 Mechanical Properties of Composites

Designation of composites	Mechanical properties					
	Tensile Strength (Mpa)	Tensile modulus (Gpa)	Flexural strength (Mpa)	Impact strength (Joule)	Hardness	ILSS (Mpa)
Ce1	119.5	3.7	214	9	86.5	7
Ce2	90.4	2.1	166.5	7	80	7.4
Cc3	96.3	2.1	186.7	8	83	6.3
Ce0	221.4	6.4	216.1	8	80.5	7.9
Cp1	176.3	1.7	388.3	12	86.5	7.3
Cp2	142.8	3.1	412.7	10	81	8.2
Cp3	143.2	4.0	585.1	10	83	11.7
Cp0	148.9	2.8	341.2	10	80.5	6.8

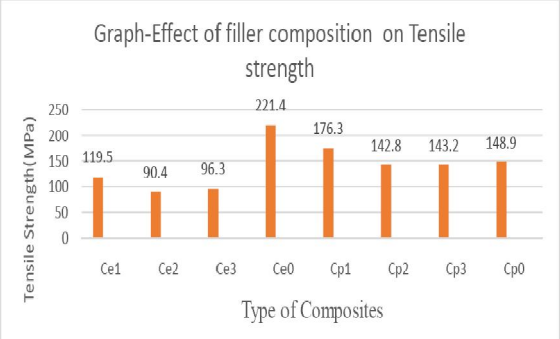

Figure-1: Graph of composite type VS Tensile strength

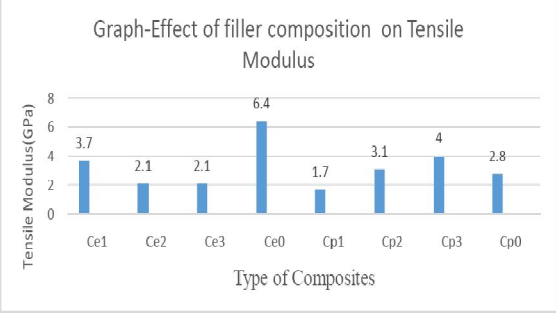

Figure-2: Graph of composite type VS Tensile Modulus

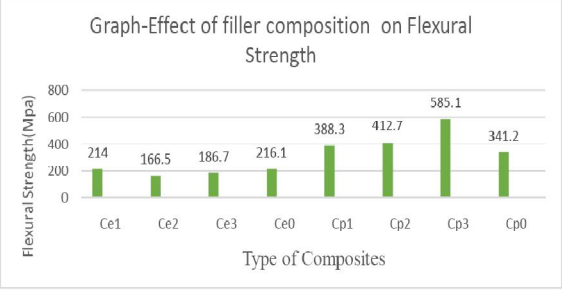

Figure-3: Graph of composite type VS Flexural Strength

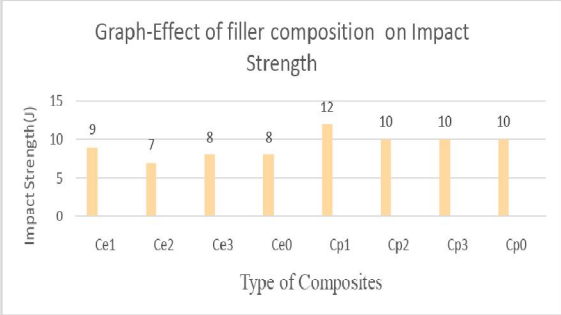

Figure-4: Graph of composite type VS Impact Strength

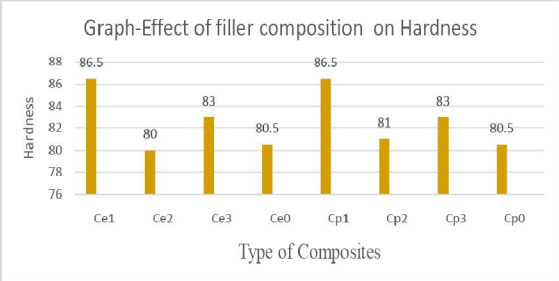

Figure-5: Graph of composite type VS Hardness

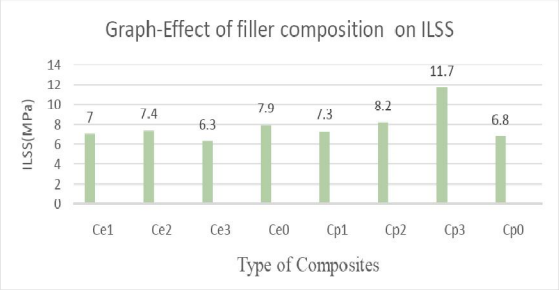

Figure-6: Graph of composite type VS ILSS

- From the figure-1,the tensile strength (221.4 Mpa) is more for the composite of designation Ce0. This is due to
  - The strong interface adhesion between polyester resin and filler particles
  - Excellent particle dispersion in polymer matrix
  - Hybridization effect

  The decrease in tensile strength of composites is due to the irregular shapes of the fillers and presence of pores at the interface between the matrix and filler particles.
- From the Figure-2, graph for composites VS tensile modulus, the tensile modulus for the composite Ce0 is maximum and is equal to 6.4GPa this is because of good adhesion between glass fiber and polymer resin. Decrease in tensile modulus is due to presence of pores between glass fiber threads.
- From the figures-3&6, graph of composites VS flexural strength and graph of composites VS ILSS it is observed that the composite Cp3 exhibited maximum flexural strength (585.1 Mpa) and ILSS of (11.7 Mpa), Due to good

adhesive strength of matrix and glass fiber reinforcement and filler in composite Cp3.

- From the figure- 4 &5, graph of composites VS Impact strength and Graph of Composite VS Hardness, it is observed that the impact strength (12 Joule) and hardness (86.5) are maximum for the composite of designation Cp1. This is due to good bonding between the fillers and matrix.

CONCLUSIONS

The experimental investigation on mechanical characterization of glass fibre reinforced polyester based hybrid composites lead to the following conclusions:

1. Fabrication of polyester/epoxy based glass reinforced particulate filled composites has been done successfully by hand lay -up technique.
2. Mechanical properties like tensile strength, tensile modulus, flexural strength, impact strength, ILSS and Hardness were determined as per ASTM standards

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