Evaluation of Tensile Strength of Epoxy Reinforeced with Fly Ash And E-Glass Fiber

Mohd Nayeem[1], Babu Reddy[2], Ambadas[3]
[1]Dept of Machine Design
[2, 3]Assistant Professor, Dept of Machine Design
[1, 2, 3] VTU CPGS Kalaburagi

Abstract- *Composites are replacing conventional materials day by day from very ample range such as automobile industries to aviation industries, medical tools to space exploration vehicle and satellites. In this research work Fly ash and E-Glass fiber are reinforced with epoxy resin. The weight percentage of E-Glass fiber is fixed and it is 10%. The weight fraction of Fly ash is varied from 0 to 12% in steps of 4%. The prepared composite material is machined to the shape of tensile specimen as per ASTM Standard D638. Three specimen of each weight fraction is prepared. Then tension test test for all specimen is performed on a Universal testing machine. It was noted that the tensile strength of composite material increases with the increase in the weight fraction of Fly ash*.

Keywords- Composites, E-Glass fiber, ASTM-D638, Universal testing machine.

I. INTRODUCTION

A composite material is formed by combining at two or more materials which have altogether different properties. The two materials cooperate to give the composite one of a kind properties. In any case, inside the composite you can undoubtedly differentiate the distinctive materials one from the other as they don't break down or mix into each other. Glass fiber reinforced polymers are becoming very popular and finds application in various fields. Glass fiber strengthened composites are utilized to make air ship parts, for example, wings, helicopter rotor edges and motor conduits. Polyster reinforced with glass fibers is normally used in manufacture different sizes of boats.

II. LITERATURE SURVEY

After metal melting and ceramics modeling, industrial-scale manufacture of the first synthetic polymer represented another landmark in the evolution of human society. Since then, polymers have witnessed an exponential development. Fiber-reinforced polymers are widely used as structural materials for relatively low-temparature use. Polymeric materials are currently being used on a very large scale, the annual global production reaching over 130 million tones [1].

Glass fiber reinforced polyester composites have played a dominant role for a long-time in a variety of applications for their high specific strength, stiffness and modulus. The tensile strength will be increased as the fiber percentage addition increased, where these fibers will be distributed on large area in the resin [2].

Advanced composite materials can offer a range of advantages, which have made them desirable in many high performance applications. The manufacturing process known as `hand layup' involves manually laying down individual layers or `plies' of a form of reinforcement known as `prepreg'. This consists of thousands of fibers, which are pre-impregnated with resin and bundled into tows and arranged either in a single unidirectional ply or woven together. This can produce high-quality complex features, has relatively low start-up costs, and is highly adaptable to new parts and design changes[3]

Epoxy resins are the extensively used thermoset materials in polymer composites. They have good bonding strength to other materials, good chemical and environmental resistance, good chemical properties and good insulating properties, and are generally manufactured by reacting epichlorohydrin with bisphenol . Epoxy resins are also used in coating industry as surface coating materials due to their toughness, flexibility, adhesion and chemical resistance. using of SiC and Graphite as filler materials in glass epoxy composites increased the wear resistance of the composite greatly[4].

III. MATERIALS

EPOXY RESIN

Epoxy resin is a chemical compound containing two or more epoxide groups per monomer, and this molecule contains a tight C—O—C ring structure. During polymerisation, the hardener opens the C—O—C rings, and the bonds are rearranged to join the monomers into a three-dimensional network of crosslinked chain-like molecules. The cure reaction for certain types of epoxy resins occurs rapidly at room temperature, although many of the high-strength epoxies used in aircraft need to be cured at an elevated temperature (120–180 °C). Epoxy resins are the polymer of choice in many aircraft applications because of their low shrinkage and low release of volatiles during curing, high strength, and good durability in hot and moist environments.

Figure-1 : Epoxy resin and Hardener

Properties	Units	Values
Tensile strength	N/mm²	85
Glass transition temperature	°C	120-130
Elongation at break		0.8%
Compressive strength	N/mm²	190

E-Glass Fiber

Glass fiber is a material consisting of numerous extremely fine fibers of glass. Glass fiber is formed when thin strands of silica-based or other formulation glass are extruded into many fibers with small diameters. The most common types of glass fiber used in fiberglass is E-glass, which is alumino-borosilicate glass with less than 1% w/w alkali oxides, mainly used for glass-reinforced plastics. Other types of glass used are A-glass (Alkali-lime glass with little or no boron oxide), E-CR-glass (Electrical/Chemical Resistance; alumino-lime silicate with less than 1% w/w alkali oxides, with high acid resistance), C-glass(alkali-lime glass with high boron oxide content, used for glass staple fibers and insulation), D-glass (borosilicate glass, named for its low Dielectric constant), R-glass (alumino silicate glass without MgO and CaO with high mechanical requirements as reinforcement), and S-glass (alumino silicate glass without CaO but with high MgO content with high tensile strength).


Figure4: E-Glass fiber

Table-1 : Properties of E-Glass Fibers

Properties of E-glass fibers	Units	Values
Density	g/cm^3	1.16
Specific gravity		2.68
Thermal conductivity	W/mK	1.30
Tensile Strength	Mpa	1700
Young's Modulus	Gpa	72

Fly Ash

Fly ash is a coal combustion product that is composed of the particulates (fine particles of burned fuel) that are driven out of coal-fired boilers together with the flue gases. Ash that falls to the bottom of the boiler is called bottom ash. In modern coal-fired power plants, fly ash is generally captured by electrostatic precipitators or other particle filtration equipment before the flue gases reach the chimneys. Together with bottom ash removed from the bottom of the boiler, it is known as coal ash. Fly ash particles are generally spherical in shape and range in size from 0.5 µm to 300 µm.

Figure 3: Fly ash

IV. PREPARATION OF COMPOSITE

The hybrid composite is made by reinforcing the E-Glass fiber and Fly ash with epoxy resin. The composite material was prepared by Hand layup technique. A metal mould was used in the preparation of the composite material. The dimensions of the mould are 350mm X 350mm X 10mm. The bottom of the mould is first coated with wax and then the mixture of the epoxy, E-Glass fiber and fly ash in the required proportion is poured into the mould and is flat rolled. The mixture is allowed to solidfy and upon the solidification the composite material is machined to the size of the ASTM D638 tension specimen. The process is repeated to get the casting with different weight fraction of fly ash.

Figure 4: Mold coated with wax

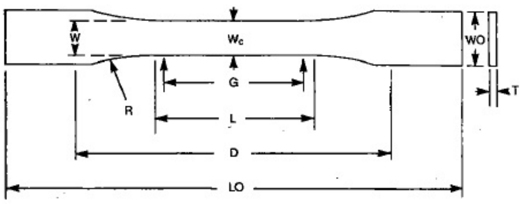

Figure 5: Specimen Dimensions

Dimensions	Values
W-Width of narrow section	13mm
L-Length of narrow section	57mm
Wo-Width overall, min	19mm
Lo-Length overall, min	165mm
Guage length	50mm
R-Radius of filet	76mm
T-Thickness	10mm

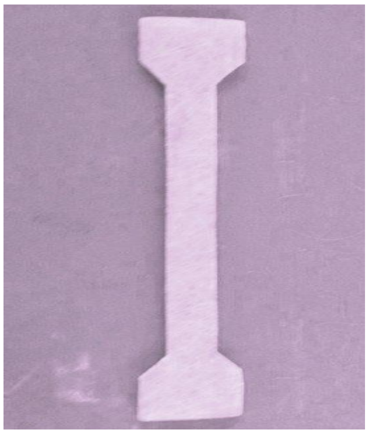

Figure 5: Composite specimen machined to ASTM D638

Table 2: Composition of different Castings

Casting No.	Epoxy	E-Glass Fiber	Fly ash
Casting-1	90%	10%	0%
Casting-2	86%	10%	4%
Casting-3	82%	10%	8%
Casting-4	78%	10%	12%

V. TEST AND RESULT

The prepared specimens are then tested on a universal testing machine(UTM) of 100KN capacity. First the extensometer is fixed on the gauge length of the specimen and then the specimen is fixed on the UTM. First the lower end of the specimen is gripped and then the upper end. Then with the help of computer the load is gradually increased and the load at which the specimen breaks gives the tensile strength. The following results are obtained from the test performed :

Casting	Specimen	Ultimate tensile strength(MPa)	
Casting-1	T11	15.22	15.21
	T12	15.15	
	T13	15.26	
Casting-2	T21	18.13	18.16
	T22	18.37	
	T23	17.98	
Casting-3	T31	23.28	23.44
	T32	23.49	
	T33	23.56	
Casting-4	T41	22.29	22.14
	T42	21.97	
	T43	22.18	

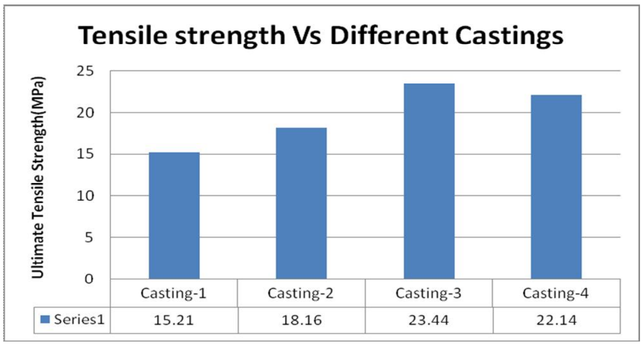

Figure 6: Ultimate tensile strength

VI. CONCLUSION

Following conclusions are drawn from the work performed:

- The hybrid composite material of Epoxy, E-Glass fiber and Fly ash was prepared successfully.
- Addition of the fly ash effects the properties of the composite significantly.
- The ultimate tensile strength of the composite increases with the increase in weight percentage of the fly ash.
- An increase of 53.46% in Ultimate tensile strength is observed in casting-3 which contain 8% of Fly ash.
- The ultimate tensile strength is decreased in casting-4 which contains 12% of Fly ash. It can be inferred that the weight percentage of fly ash should not be increased beyond 10%.

REFERENCES

[1] Raluca Maria Florea, "Elements Polymer Matrix Composites – Routes And Properties, International Journal of Modern Manufacturing Technologies.

[2] M. S. EL-Wazery, "Mechanical Properties of Glass Fiber Reinforced Polyester Composites", International Journal of Applied Science and Engineering.

[3] Ru Min Wang, "Polymer matrix composites and technology", Woodhead Publications.

[4] Tayfun Uygunoglu, "Physical and Mechanical Properties of Polymer Composites with High Content of Wastes Including Boron", Materials Research. 2015; 18(6): 1188-1196.

[5] Fredrick T, Wallenberger, James C Watson and Hong Li, " Glass Fibers", PPG Industries Inc.

[6] P.K. Rohatgi, J.K. Kim, N. Gupta, Simon Alaraj, A. Daoud.. "Compressive characteristics of A356/fly ash cenosphere composites synthesized by pressure infiltration technique".Composites: Part A. 37: 430- 437, 2006.

[7] Sudarshan M.K. Surappa.. "Synthesis of fly ash particle reinforced A356 Al composites and their characterization. Materials Science and Engineering" A. 480 (2008) 117-124,2007.

[8] P.K. Rohatgi, R.Q. Guo, H. Iksan, E.J. Borchelt, R. Asthana.. "Pressure infiltration technique for synthesis of aluminum-fly ash particulate composite". Materials Science and Engineering A. 244: 22-30, 1998.

[9] K.Devendra, and T.Rangaswamy, Strength characterization of E-glass fiber reinforced epoxy composites with filler materials, Journal of Minerals, Material Characterization and Engineering, 2013:(1),pp.353-357.

[10] Amar Patnaik and S.S Mahapatra, Study on mechanical and erosion wear behavior of hybrid composites using taguchi experimental design, Journal of Materials and Design, 2009:(30),pp.2791-2801.

[11] S.Chauhan, A.Kumar, A.Patnaik, A.Satapathy and I.Singh, Mechanical and wear characterization of GF reinforced vinyl ester resin composites with different comonomers, Journal of Reinforced Plastic Composites, 2009: (28), pp.2675-2684.