# Fabrication and Testing Of Copper Based Polymer with E-Glass and Fly Ash Reinforced Polymer Composites

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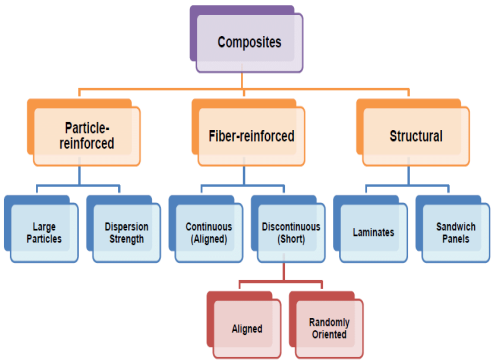
***Abstract*— This study investigates the fabrication and mechanical characterization of copper-based polymer composites reinforced with E-glass fiber and fly ash. Using a hand layup technique, various compositions were prepared with copper, E-glass fiber, fly ash, and unsaturated polyester resin. Mechanical properties including tensile strength and impact resistance were evaluated. The results show that hybrid composites exhibit superior mechanical properties compared to single-fiber composites. The best performance was observed in composites with an equal distribution of all constituents, indicating a synergistic reinforcement effect.**

***Keywords:*** **Composite materials, E-glass fiber, fly ash, copper, polymer matrix, tensile strength, impact resistance, hand layup**

## INTRODUCTION

Composite materials have revolutionized material engineering by combining the advantages of multiple constituents to enhance mechanical properties. With increasing demand in aerospace, automotive, and construction sectors, polymer matrix composites (PMCs) reinforced with synthetic and natural fillers have gained prominence. This study explores a hybrid composite composed of copper, E-glass fiber, and fly ash reinforced within a polyester resin matrix. The aim is to improve the mechanical strength and impact resistance of the resulting material. The mechanical shortcomings of homogenous materials and the need for composites were realized in the early 1950s, with the advent of the space age. Almost all homogenous materials have their inherent shortcomings in mechanical respect. When they are stiff and sufficiently hard, they are most brittle and hardly processable. They are ductile and well processable; they are not stiff and hard enough. By the combination of materials, it proved

The composite materials have advantage over other conventional materials due to their higher specific properties such as tensile, impact and flexural strengths, stiffness and fatigue characteristics, which enable the structural design to be more versatile. Due to their many advantages, they are widely used in the aerospace industry, in a large number of commercial mechanical engineering applications, such as machine components, Internal combustion engine parts, railway coaches, flywheels, process industries, sports and leisure equipment; marine structures; and biomedical devices.




## LITERATURE REVIEW

This section focuses on the research work that has already been carried out for testing the mechanical properties of the glass Fiber Reinforced Hybrid composites. Literature review of such work needs to be done in order to understand the background information available, the work already done and also to show the relevance of the current project. This chapter presents a general idea of the factors which affect the mechanical properties of hybrid fiber reinforced polymer composites in polymer composites, the matrix is the major load bearing component. In order to increase this load bearing capability, the reinforcements are introduced in the matrix.Currently, natural fibers and artificial fibers like glass, jute etc., are being widely used in polymer-based composites because of their high strength and stiffness properties.

According to R.D. HEMANTH, M. SENTHILKUMAR, AJITH GOPINATH & L. NATRAYAN Composite manufacturing is the novel branch of science, which finds its immense applications in various industries such as sporting, automotive, aerospace and marine industries. The superior properties of composites such as stiffness, better mechanical properties, low density and light weight make it a candidate in engineering applications. The need for seeking alternate materials with increased performance in the field of composites revived this research, to prepare fiber reinforced composites.

According to A. MANIKANDAN, R. Rajkumari al The objective of this work is to investigate the mechanical properties of Glass fiber reinforced Epoxy composites with different weight proportions. Using injection molding, five composites were prepared by varying the weights. The necessary mechanical tests were conducted as per ASTM standards. Fiber Reinforced Polymer (FRP)composite materials are currently considered as universal engineering materials and they are utilized in a spacious range of applications, because of their elevated specific strength and high specific stiffness.

## METHODOLOGY

In this study we have selected copper as the main material as it is having low strengthening properties and high thermal conductivity. Study of different materials like glass fibers, artificial fibers, different resins, different techniques, different mechanical tests etc.Copper,E-glass fiber, Fly-ash, Unsaturated Polyester resin, Accelerator and Catalyst materials are selected. olds are prepared as per ASTM standards. By using different methods and materials Fiber reinforced composites are prepared by different weight proportions.
Different mechanical tests are performed on prepared fibre reinforced composites. Graphs are drawn and results are compared.

## MATERIALS AND METHODS

Copper: Selected for its excellent conductivity and strength improvement when alloyed or combined with reinforcements.

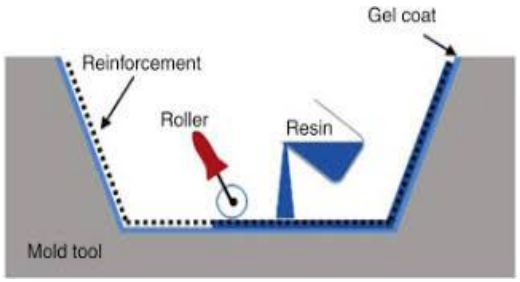
E-Glass Fibre: Known for its high tensile strength and stiffness.

Fly Ash: A low-cost industrial by product with pozzolanic properties, used to enhance wear resistance.

Unsaturated Polyester Resin: Serves as the binding matrix due to its strong mechanical properties and chemical resistance.

Fabrication Method:

Thermo-set composites are fabricated either using “wet- forming” processes, or processes which used premixes or prepress. In wet- forming processes, resin in fluid state is used, while forming the final product. The resin gets cured in the product while the resin is “wet”. This curing may be aided by application of external heat and pressure
Typical wet- forming processes include: –
Hand layup
Bag moulding
Filament winding
RTM (resin transfer moulding)
Pultrusion.
The hand layup method was employed to fabricate composite samples. The reinforcement components (copper, E-glass fiber, and fly ash) were uniformly distributed in the resin matrix, poured into pre-prepared wooden molds, and cured at room temperature. Three main compositions were fabricated:
Sample A: 40% copper, 40% fly ash, 20% resin
Sample B: 40% copper, 40% E-glass fiber, 20% resin
Sample C: 25% copper, 25% E-glass fiber, 25% fly ash, 25% resin




## TESTING PROCEDURES

Tensile Test: Conducted using ASTM E8 standards on a universal testing machine to evaluate strength and elongation.

Impact Test: Conducted using ASTM D256 standards to determine impact energy absorption.

## MATERIALS USED

Copper
E-glass fiber
Fly-ash
Unsaturated Polyester resin
Accelerator (Cobalt Octoate)
Catalyst (MEKP)

MOULD PREPARATION

The wooden mould is prepared as per requirements. And grease or any oil is applied to the mould for smooth removal of the specimen.

Fabrication of Artificial Fiber of Copper,E-glass Composites

Here we are using hand layup technique for preparing samples. A mixture of Polyester resin and hardener is mixed in equal ratio for example if we take 100 ml of resin, we have to take 10 ml of accelerator i.e., 10:1 ratio of resin and catalyst mixture is taken for each layer of specimen preparation.

Then the prepared dough was transferred to the prepared molds with care that the mound cavity should thoroughly filled. Leveling was done for uniformity of the layer.

While the process is going on the glass fiber is cut ten as per the mold dimensions and placed on that base layer and vaccination is done and then a layer of resin and accelerator mixture is gently applied with the help of a roller. One layer after another is gently applied and the process goes on till, we obtain required thickness of the specimen as per standard dimensions with required ratio of copper ,glass fiber and resin mixture.

PREPARATION OF COPPER, FLY-ASH PARTICULATES

In this preparation copper particles are spread on the resin Baise and Fly ash is produced by coal-fired. Typically, coal is pulverized and blown with air where it immediately ignites, generating heat and producing a molten mineral residue. the molten mineral residue to harden and form ash. Coarse ash particles, referred to as bottom ash or slag, fall to the bottom of the combustion chamber, whilethe lighter fine ash particles, termed fly ash, remain suspended in the flue gas. Prior to exhausting the flue gas, fly ash is removed by particulate emission control devices, such as electrostatic precipitators or filter fabric baghouses.

Fly ash is produced from the combustion of coal in electric utility. Fly ashes produced by coal or wood fired. Fly ash is captured from the burned coal or wood pieces. The physical and chemical characteristics of fly ash vary among combustion methods, coal source, and particle shape.

Preparation of Copper, E-glass Fiber and Fly-ash composites

Here we are using hand layup technique for preparing samples. A mixture of polyester resin and accelerator is mixed in different ratio for example if we take 100 ml of resin, we have to take 10 ml of catalyst i.e., 10:1 ratio of resin and accelerator mixture is taken for each layer of specimen preparation

CURING

After the specimen is prepared then it must be cured for few hours at room temperature or at a place where it cures quickly

DEMOULDING

The cured workpiece is removed from mold and cut into the standard dimensions for TESTING.

Cutting of Laminates into Samples of Desired Dimensions:

A WOOD CUTTER blade was used to cut each laminate into smaller pieces, for various experiments:

- TENSILE TEST- Sample was cut into a bar as per ASTM
- IMPACT TEST- Sample was cut into flat shape with notch at center as per ASTMD-256(IMPACT).

RESULTS AND DISCUSSION

TENSILE STRENGTH

Sample A recorded an average tensile strength of 12.34 MPa. Sample B achieved 56.42 MPa, while Sample C achieved the highest at 70.09 MPa. The improved tensile strength in Sample C is attributed to the combined reinforcing effects of fiber and particulates, which distribute load effectively within the matrix.

IMPACT RESISTANCE

Impact energy absorption results were as follows:

Sample A: 100.5 J
Sample B: 129 J
Sample C: 139 J

The hybrid Sample C again outperformed the others, suggesting that the dual reinforcement of E-glass and fly ash maximizes energy dissipation during impact.

DISCUSSION

The hybrid reinforcement approach significantly enhances mechanical performance. E-glass fiber provides strength and stiffness, while fly ash contributes to wear resistance and structural integrity. Copper enhances thermal and electrical properties while acting as a filler to reinforce the matrix.

CONCLUSION

The study successfully demonstrates the feasibility of fabricating high-performance polymer composites using copper, E-glass fiber, and fly ash. Hybrid composites showed the best mechanical properties, indicating potential applications in infrastructure, automotive, and industrial sectors. Future work could explore other filler materials, assess long-term durability, and extend testing to fatigue and tribological performance.

REFERENCES

[1] Muhammad Z. Khelifa, HayderMoasa Al-Shukri "Fatigue Study Of E-Glass Fiber Reinforced Polyester Composite Under Fully Reversed Loading and Spectrum Loading" Eng. & Technology, Vol.26, No.10, 2008.

[2] Elsayed A. Elbadry, Mohamed S. Aly-Hassan, and Hiroyuki Hamada "Mechanical Properties of Natural Jute Fabric/JuteMatFiber Reinforced Polymer Matrix Hybrid Composites" Advances in Mechanical Engineering Volume 2012, Article ID 354547, September2012.

[3] Mahmood.M Shokrieha, Mohammad A Torabizadeh, Abdolhossein Fereidoon "Dynamic failure behavior of glass/epoxy composites under low temperature using Charpy impact test method" Indian Journal of Engineering & Materials Sciences Vol. 18, June 2011, pp.211-220.

[4] C. C. Chamis and J. H. Sinclair "Impact Resistance of Fiber Composites: Energy absorbing Mechanisms and EnvironmentalEffects" NASA Technical Memorandum 83594 Impact Factor (JCC): 6.8765 NAAS Rating:3.11

[5] K. Devendra, T. Rangaswamy "Evaluation of Thermal Properties of E-Glass/ Epoxy Composites Filled by Different Filler Materials" International Journal of Computational Engineering Research (ijceronline.com) Vol. 2,Issue.5.