Enhancing Mechanical Characteristics of Plastic Waste Reinforced Fly Ash with Use of Epoxy Resin

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Abstract— **This study explores the possibility of enhancing the mechanical properties of a composite material consisting of plastic waste and fly ash by employing epoxy resin as a binding agent. Plastic waste, which poses a significant environmental challenge, and fly ash, a byproduct of coal combustion, were selected as constituents due to their widespread availability and potential for reuse. Through a sequence of experimental procedures encompassing material characterization, composite fabrication, and mechanical testing, we examined the influence of epoxy resin on the structural integrity and strength of the composite. Our findings reveal that incorporating epoxy resin leads to a notable improvement in the mechanical characteristics of the composite, suggesting promising applications in the construction and manufacturing sectors as a sustainable substitute for conventional materials. This research contributes to the development of environmentally friendly composite materials and addresses the urgent need for innovative approaches to waste management and resource utilization.**

Keywords—Plastic waste, Fly ash, Epoxy resin, Mechanical properties, Material characterization, Composite fabrication, Composite testing, Structural integrity, Composite Strength, Manufacturing, Environmental friendly.

I. INTRODUCTION

The escalating environmental concerns related to plastic waste necessitate sustainable solutions. Plastic waste disposal poses significant challenges, and finding innovative ways to utilize it is crucial. Fly ash, a byproduct of coal combustion, is abundant and cost-effective. It has been explored as a reinforcement material in various applications. The use of epoxy resin as a matrix material offers promising opportunities for enhancing the mechanical properties of composites.In this study, we investigate the

synergistic effects of combining plastic waste, fly ash, and epoxy resin to create a composite material with improved mechanical characteristics. Content: Background: Discuss the environmental impact of plastic waste and the need for sustainable alternatives. Introduce fly ash as a potential reinforcement material due to its availability and low cost.Objective:Our primary objective is to enhance the mechanical properties of plastic waste-fly ash composites using epoxy resin. Methodology: Describe the experimental setup, including the preparation of plastic waste, fly ash, and epoxy resin. Explain any surface treatments or modifications applied to the materials. Results and Discussion: Present the findings from mechanical tests, such as tensile strength, flexural strength, and impact resistance. Analyze how the addition of epoxy resin influences the composite's mechanical behavior. Compare your results with existing literature. Conclusion : Summarize the study's key outcomes. Highlight the potential applications of plastic waste-fly ash composites reinforced with epoxy resin. Address any limitations and propose avenues for future research.

A. Composite materials

Composite materials are engineering materials made from two or more constituent materials that remain separate and distinct on a macroscopic level while forming a single component. There are two categories of constituent materials: matrix and reinforcement. The matrix material surrounds and supports the reinforcement materials by maintaining their relative positions. The reinforcements impart their special mechanical and physical properties to enhance the matrix properties. The primary functions of the matrix are to transfer stresses between the reinforcing fibers/particles and to protect them from mechanical and/or environmental damage whereas the presence of fibers/particles in a composite improves its mechanical properties such as strength, stiffness etc. The objective is to take advantage of the superior properties of both materials without compromising on the weakness of either.

B.Properties

a. Nature of the constituent material (bonding strength)
b. The geometry of the reinforcement (shape, size)
c. The concentration distribution (vol. fraction of reinforcement)
d. The orientation of the reinforcement (random or preferred)

II. LITERATURE REVIEW

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III. MATERIALS

This chapter describes the details of processing of the composites and the experimental procedures followed for their mechanical characterization. The raw materials used in this work are

✓ PLASTIC WASTE
✓ FLY ASH WITH

✓ EPOXY RESIN.

a. Plastic Waste

Plastic pollution, accumulation in the environment of synthetic plastic products to the point that they create problems for wildlife and their habitats as well as for human populations. In 1907 the invention of Bakelite brought about a revolution in materials by introducing truly synthetic plastic resins into world commerce. By the end of the 20th century, plastics had been found to be persistent polluters of many environmental niches, from Mount Everest to the bottom of the sea. Whether being mistaken for food by animals, flooding low-lying areas by clogging drainage systems, or simply causing significant aesthetic blight, plastics have attracted increasing attention as a large-scale pollutant.

Fly ash is the finely divided residue that results from the combustion of pulverized coal and is transported from the combustion chamber by exhaust gases. Over 61 million metric tons (68 million tons) of fly ash were produced in 2001. Fly ash is produced by coal-fired electric and steam generating plants. Typically, coal is pulverized and blown with air into the boiler's combustion chamber where it immediately ignites, generating heat and producing a molten mineral residue. Boiler tubes extract heat from the boiler, cooling the flue gas and causing 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, while the 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. Currently, over 20 million metric tons (22 million tons) of fly ash are used annually in a variety of engineering applications. Typical highway engineering applications include: portland cement concrete (PCC), soil and road base stabilization, flowable fills, grouts, structural fill and asphalt filler.

c. Epoxy Resin

Epoxy is the family of basic components or cured end products of epoxy resins. Epoxy resins, also known as polyepoxides, are a class of reactive prepolymers and polymers which contain epoxide groups. The epoxide functional group is also collectively called epoxy. The IUPAC name for an epoxide group is an oxirane.

Epoxy resins may be reacted (cross-linked) either with themselves through catalytic homopolymerization, or with a wide range of co-reactants including polyfunctional amines, acids (and acid anhydrides), phenols, alcohols and thiols (sometimes called mercaptans). These co-reactants are often referred to as hardeners or curatives, and the cross-linking reaction is commonly referredto as curing.

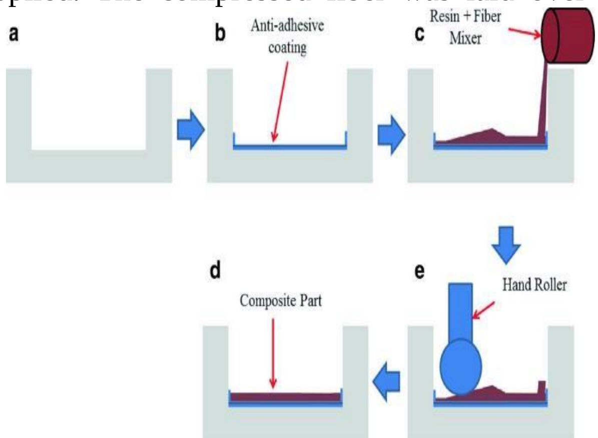
IV.FABRICATION WORK

a. Hand Lay Up Method

Hand Layup technique was employed for the preparation of the natural fiber reinforced polymer composite; mould made of mild steel was used with dimensions of 230×270×10mm for mechanical behavior test and another mould made of SS was used with dimensions of 230×270×10mm for compressive test. This method is the cheapest method of manufacturing but it has some disadvantages such as long curing time, low production rate, and further the quality of the composite depends on the skill of the worker. The fibers were placed in the mold evenly and thermosetting resin is mixed with promoter and catalyst. Mold release agent is applied all over the mold surface. A brush or roller is used to wrap layering process of the fibers. Layers of the fibers impregnated with the resin are used to build up the require thickness. Curing,

b. Processing Of Plastic Waste Reinforced Fly Ash With Use Of Epoxy Resin

First we collect the plastic waste slit then extract the slit and make plastic waste extraction machine. Then collect the plastic waste in poultry industry and first clean in water then dry in sunlight. Then we make a standard mould piece like (300 mm X 270 mm X 10 mm). The mould plate made from stainless steel The moulds are cleaned and dried before applying epoxy. Then a coat of wax layer is applied throughout the board to facilitate easy removal of the laminate. The fibers were laid uniformly over the mould before applying any releasing agent or epoxy. After arranging the fibers uniformly, they were compressed for a few minutes in the mould. Then the compressed form of fibers (plastic waste and fly ash) is removed from the mould. This was followed by applying the releasing agent on the mould, after which a coat of epoxy resin was applied. The compressed fiber was laid over the



coat of epoxy, ensuring uniform distribution of fibers. The polyester mixture is then poured over the fiber uniformly and Hand Layup for a curing time of 7 hour. plastic waste and fly ash are cleaned thoroughly and later chopped them in tiny sizes and the chemical composition of plastic waste and fly ash.

c. Fabricated Composite Images For Plastic Waste And Fly Ash Mould Fabrication Work

The images of the fabricated materials taken through Machine vision instrument are as follow

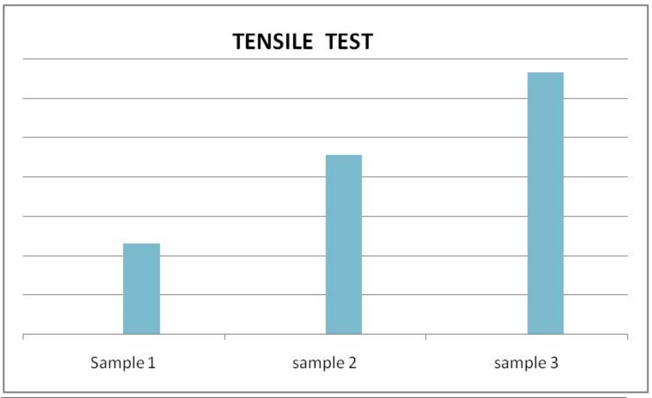
d. Moulding plate

plastic waste and fly ash plate

V.RESULT DISCUSSION

a. Tensile Test

The tensile strength of a material is the maximum amount of tensile stress that it can take before failure. According to ASTM D3039-76 test models the tensile test of composites is carried out utilizing Universal Testing Machine UNITEK 94100. A load was connected to the both sides of composite samples for the testing. The speed of the tensile testing machine isabout 5 mm/min.

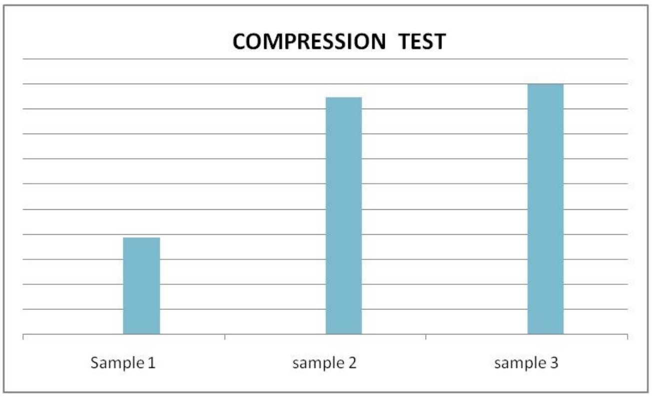


Sample Ratio	%Elongation	UTS [kg/cm^2]
70:30	3.820	80.644
65:35	3.869	81.776
60:40	3.926	82.820

b. Compression Test

compression test is any test in which a material experience opposing forcesthat push inward upon the specimen from opposite sides. The test samples are generally placed in between two plates that distribute applied loadacross the entire sample

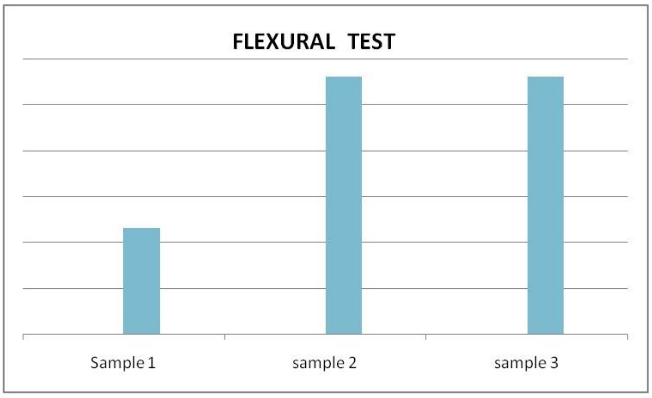
Sample Ratio	Peak Load [N]	Compression Strength [kg/cm^2]
70:30	1982.878	72.369
65:35	1982.878	73.492
60:40	1982.878	73.593



SampleRatio	Flexural Strength (MPa)	Flexural Modulus(GPa)
70:30	84.293	1763.826
65:35	85.473	1763.892
60:40	86.482	1764.957

c. Flexural Testing

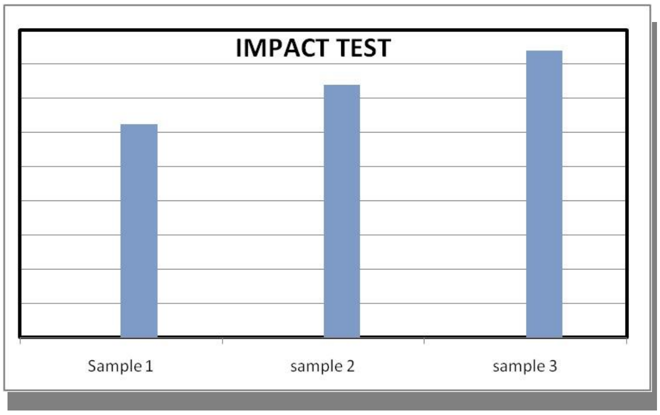
Flexural Strength is defined as a materials ability to resist deformation under load. Flexural test is conducted as per ASTM D790 standard using Universal Testin Machine. The maximum fiber tress at failure on the tension side of a flexural specimen is considered the flexural strength of the material.For the testing, the cross head rate is kept as 2 mm per min and a span of 80 mm is kept up. Four composites specimen were tested for each sample andeach test was performed until failure occurred.



SampleRatio	Flexural Strength (MPa)	Flexural Modulus(GPa)
70:30	84.293	1763.826
65:35	85.473	1763.892
60:40	86.482	1764.957

d. Impact Strength

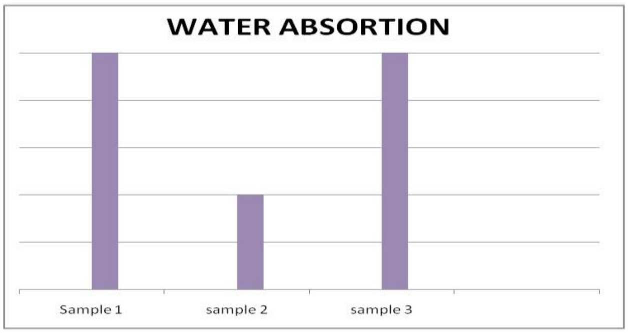
Impact is a single point test that measures a materials resistance to impact from a swinging pendulum. Impact is defined as the kinetic energy needed to initiate fracture and continue the fracture until the specimen is broken. The impact tests are carried out as per ASTM D 256 using an impact tester. Four samples were tested at ambient conditions and the average of impact strength was calculated.



Sample Ratio	Sample Number	Izod Impact value in (J)
70:30	Plate 1	12.5
65:35	Plate 2	14.8
60:40	Plate 3	16.8

e. Water Absorption Test

Specimen which undergone water absorption test three specimens are differed radio tested noted. Weight of the 1st specimen before the water absorption test is 2.42 gsm. then the specimen 1st is taken out from the water after 48 hours then the weight of the specimen 2.43 gsm . As a result the percentage of absorption of water in specimen 1st is 0.01%. Wight of the 2nd and 3rd specimen before the water absorption test is 2.44 & 2.41gsm. Then the specimen 2nd and 3rdis taken out from the water after 48 hours then the weight of the specimen 2.44 &2.44 gsm. As a result the percentage of absorption of water in specimen the 2ndand 3rd is 0.00 & 0.01. As an average of these specimen is 0.00%.



Sample Ratio	Weight before test in gsm	Weight after testin gsm (48hrs)	% of water absorption
70:30	2.42	2.43	0.01
65:35	2.44	2.44	0.00
60:40	2.41	2.42	0.01

VI.CONCLUSION

In the experimental study, the plastic waste and fly ash are used as a reinforcing material with polyester resin, the composites have been fabricated and physical characteristics of these materials are examined. From the experiment, the following conclusions have been drawn.

- The maximum plate 70:30 tensile strength is **81.776 kg/cm2** which is hold by the plastic waste and fly ash feather of epoxy resin composites.
- The maximum plate 70:30 flexural strength is **85.473 MPa** and this is alsohold by the same combination of the composites sample.

- The maximum plate 70:30 impact strength **14.8 joules** plastic waste and fly ash of epoxy resin composites
- The maximum plate 70:30 Compression strength is **73.492 kg/cm2** with stand high compression strength.
- Absorption of water in specimen the average of these specimen is 0.00 %. Finale the beat mechanical properties it has wide range of engineering applications.

This work shows that successful fabrication of a plastic waste and fly ash reinforced epoxy resin hybrid composites with different weight fraction of fiber is possible by using simple compression molding technique. It has been noticed that the mechanical properties of the composites as a tensile strength, flexural strength and impact strength etc.,

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