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# Study of Concrete at Various Dosages with Fly Ash based Geopolymer and Plastic E-waste

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## ABSTRACT

This study investigates the characteristics of concrete incorporating fly ash-based geopolymer and plastic E-waste at various dosages. The aim is to explore the potential of utilizing these materials in combination to develop sustainable and innovative concrete mixtures. Fly ash-based geopolymer is considered as an eco-friendly alternative to traditional cement-based concrete, while plastic E-waste offers a solution for managing electronic waste. The study involves designing concrete mixtures with different dosages of fly ash-based geopolymer and plastic E-waste particles. The dosages are varied to assess their influence on the fresh and hardened properties of the concrete. The fresh properties, including workability, slump, and setting time, are evaluated to ensure the mixtures can be properly handled and placed. The hardened properties of the concrete, such as compressive strength, flexural strength, and durability, are assessed at different curing ages to examine the long-term performance. The influence of fly ash-based geopolymer and plastic E-waste dosages on these properties is studied to determine the optimal combination for achieving desired concrete characteristics.

## INTRODUCTION

The study aims to investigate the behavior of concrete mixtures containing varying dosages of fly ash-based geopolymer and plastic E-waste. The utilization of fly ash-based geopolymer offers an environmentally friendly alternative to traditional cement-based concrete, while incorporating plastic E-waste provides a solution for managing electronic waste.

The introduction of fly ash-based geopolymer in concrete has gained significant attention due to its potential to reduce carbon emissions and utilize industrial byproducts. Geopolymer binders, derived from the activation of fly ash with alkaline solutions, can provide comparable or even superior performance to conventional cementitious binders. This makes them a promising alternative for sustainable construction.

Simultaneously, the increasing accumulation of plastic E-waste has posed environmental challenges, necessitating effective waste management strategies. By incorporating plastic E-waste particles in concrete, the study aims to explore their potential as a supplementary material. This approach not only diverts plastic waste from landfills but also enhances the properties of the concrete, potentially improving its performance. The dosages of fly ash-based geopolymer and plastic E-waste in the concrete mixtures will be varied to evaluate their effects on the fresh and hardened properties. The fresh properties, including workability and setting time, will be assessed to ensure the mixtures can be properly handled and placed during construction. The hardened properties, such as compressive strength, flexural strength, and durability, will be evaluated to examine the long-term behavior and performance of the concrete. The aim is to determine the optimal combination of fly ash-based geopolymer and plastic E-waste dosages that can achieve the desired mechanical and durability characteristics.

**Geopolymer**

Geopolymer is a type of material that is gaining popularity in the construction industry as an alternative to traditional cement-based materials. It is an inorganic polymer composite that is formed by chemically bonding aluminosilicate materials, such as fly ash, slag, or clay, with alkaline solutions. Geopolymers offer several advantages over conventional cement, including lower carbon emissions, improved durability, and enhanced fire resistance. One of the key benefits of geopolymer is its reduced environmental impact. The production of traditional cement is responsible for a significant amount of carbon dioxide emissions. In contrast, geopolymer production emits significantly less carbon dioxide and can utilize industrial by-products such as fly ash, which would otherwise be disposed of in landfills. This makes geopolymer a more sustainable option for construction. In terms of durability, geopolymer exhibits excellent resistance to chemical attack, abrasion, and heat. It can withstand harsh conditions, making it suitable for applications in high-temperature environments, such as industrial furnaces. Geopolymer-based materials have also shown superior fire resistance compared to conventional materials. This makes them ideal for fireproofing structures and enhancing the safety of buildings.

Geopolymers can be used in a variety of construction applications, including the production of concrete, bricks, and panels. They can be molded into different shapes and sizes, offering flexibility in design. Geopolymer-based concrete has demonstrated comparable or even superior strength properties to traditional cement-based concrete. Additionally, geopolymer-based materials have been used in road construction, soil stabilization, and even 3D printing applications. However, there are still challenges to overcome in the widespread adoption of geopolymer. The high alkalinity of geopolymer mixtures can limit the range of materials that can be used as aggregates. There is also a need for further research and standardization to optimize mix designs and ensure consistent performance.

**Plastic E-waste**

Plastic e-waste refers to the electronic waste that contains a significant amount of plastic components. It encompasses discarded electronic devices, such as computers, smartphones, televisions, and other electronic gadgets, which contain various types of plastics in their construction. Plastic e-waste poses several environmental and health risks if not properly managed.

Electronics often contain a mix of plastics, including ABS (acrylonitrile butadiene styrene), polycarbonate, PVC (polyvinyl chloride), and other plastic polymers. These plastics can release hazardous substances when improperly disposed of or incinerated, leading to soil and water pollution. The release of toxic chemicals, such as brominated flame retardants and phthalates, can have detrimental effects on ecosystems and human health.

Improper handling and disposal of plastic e-waste can also contribute to the problem of plastic pollution. Many electronic devices are improperly discarded, ending up in landfills or being illegally dumped, leading to the accumulation of plastic waste. This not only affects the aesthetic value of the environment but also has long-term consequences for wildlife and marine ecosystems.

To address the issue of plastic e-waste, proper management and recycling practices are crucial. Recycling facilities can extract valuable metals and components from electronic waste while safely disposing of or recycling the plastic parts. However, recycling plastic e-waste can be challenging due to the complexity of electronic devices and the need for specialized equipment and processes.

Efforts are being made to improve e-waste recycling infrastructure and promote extended producer responsibility (EPR) programs, where manufacturers take responsibility for the end-of-life disposal of their products. Additionally, public awareness campaigns and initiatives encourage consumers to recycle electronic devices properly and promote the use of eco-friendly and easily recyclable materials in electronic manufacturing.

## SCOPE OF THE RESESRCH

The scope of this research encompasses the investigation of concrete mixtures containing varying dosages of fly ash-based geopolymer and plastic E-waste. The study aims to explore the potential benefits and limitations of incorporating these materials in concrete and assess their impact on the fresh and hardened properties of the resulting mixtures. The research will focus on evaluating the performance of concrete mixtures with different dosages of fly ash-based geopolymer and plastic E-waste particles. The dosages will be varied to cover a range of compositions, allowing for a comprehensive analysis of their effects on the properties of the concrete. The investigation will include considerations such as workability, setting time, compressive strength, flexural strength, and durability. Special attention will be given to the interaction between the fly ash-based geopolymer and plastic E-waste particles and their influence on the microstructure of the concrete. Advanced characterization techniques, such as SEM and XRD, may be employed to analyze the morphology, chemical composition, and interfacial bonding between the different components of the concrete. The environmental aspects of incorporating fly ash-based geopolymer and plastic E-waste will also be considered. The research may involve assessing the carbon footprint and sustainability of the concrete mixtures, potentially through life cycle assessments. The aim is to understand the environmental implications of using these materials and evaluate their contribution to sustainable construction practices.

## RESEARCH METHODOLOGY

Experimental design:

a. Materials selection: Determine the types and sources of fly ash, geopolymer precursors, and plastic e-waste you will use in your study. Ensure that the materials meet relevant standards and are representative of those commonly available.

b. Concrete mix design: Develop a concrete mix design that incorporates fly ash-based geopolymer and plastic e-waste at different dosages. Determine the proportions of cement, fly ash, geopolymer precursors, aggregates, water, and plastic e-waste in the mixtures.

c. Experimental variables: Identify the key variables you will study, such as the percentage of fly ash, geopolymer precursors, and plastic e-waste in the concrete mix. Determine the dosages or levels you will investigate.

d. Experimental groups: Divide the concrete mixtures into different groups representing the various dosages of fly ash-based geopolymer and plastic e-waste. Ensure you have an adequate number of replicates for each dosage group to ensure statistical significance. tests may include:

a. Compressive strength testing: Determine the compressive strength of the concrete samples at different curing times.

b. Flexural strength testing: Measure the flexural strength of the concrete specimens.

c. Durability testing: Assess the durability properties, such as resistance to chloride ion penetration or carbonation.

d. Workability testing: Evaluate the workability characteristics, such as slump and flowability, using appropriate tests.

e. Density and porosity analysis: Determine the density and porosity of the concrete samples.

f. Other relevant tests: Consider additional tests specific to your research objectives, such as thermal conductivity or leaching tests.

## RESULTS AND DISCUSSION

### Compressive Strength Test

The compressive strength test is a standard procedure used to determine the strength of concrete or other construction materials. It measures the maximum load that a specimen can bear before it fails under compression. This test is crucial in assessing the quality and durability of concrete structures.

During the test, cylindrical or cubic specimens are prepared from the concrete mixture and cured under specified conditions. After the specified curing period, usually 7 or 28 days, the specimens are subjected to a compressive force until they fail. The force is applied gradually and uniformly until the specimen fractures.

**Table 1: Compressive Strength of Fly ash and E-waste mixed concrete**

| MIX | Compressive Strength (MPa) | |
|---|---|---|
| | **7 DAYS** | **28DAYS** |
| **Normal M-25** | 19.79 | 25.58 |
| **Fly ash and E-waste mix, 10%** | 18.36 | 21.93 |
| **Fly ash and E-waste mix, 20%** | 19.82 | 25.63 |
| **Fly ash and E-waste mix, 30%** | 16.41 | 22.45 |

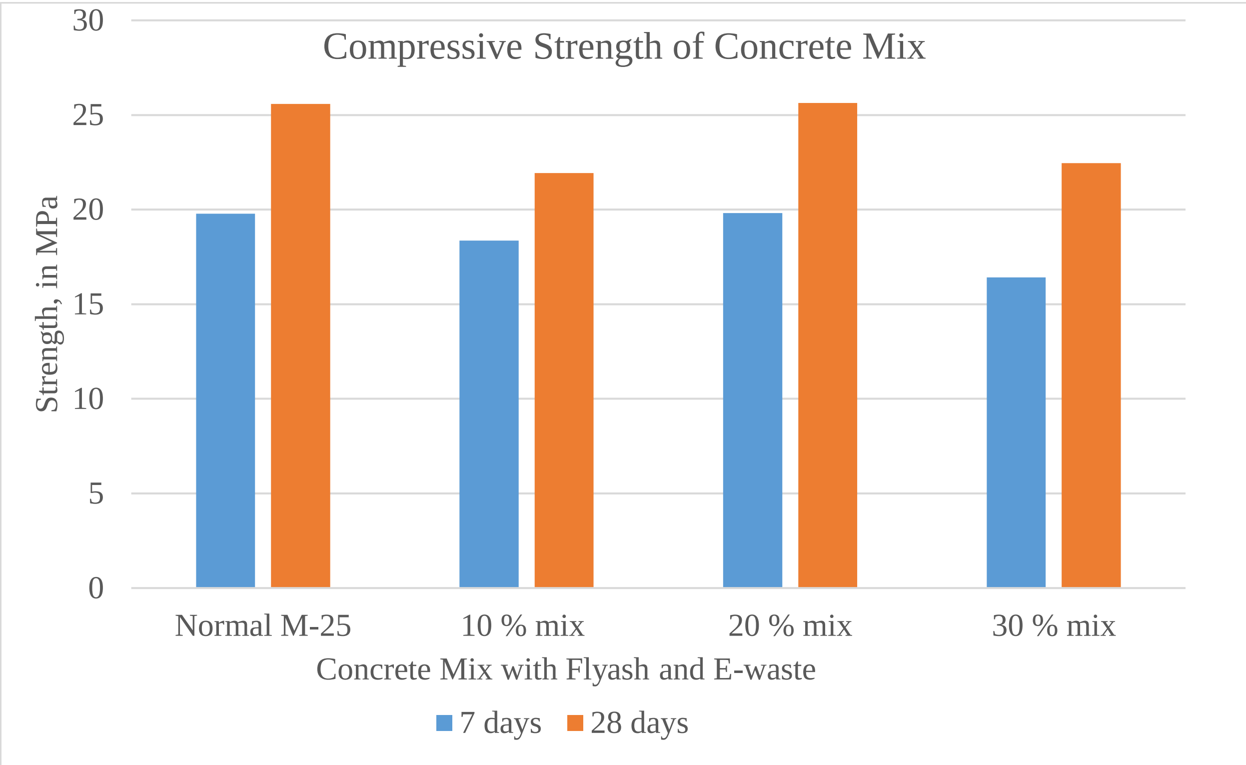


**Fig. 1 Compressive Strength**

The cube compressive strength results at 7 and 28 days for different replacement levels (10%, 20%, and 30%) of cement with fly ash and E-waste in concrete are presented in Table 1. The highest compressive strength of 25.63 N/mm2 was observed in the 20% mixture.

**Flexural Strength Test Result**

In this study, a total of six beams were constructed using different percentages (10%, 20%, and 30%) of glass powder mixed with concrete. Furthermore, two beams were made using ordinary cement concrete. The specimens underwent curing for varying durations of 7 and 28 days. The results of the study indicate that the average flexural strength of the concrete mixture with 20% fly ash and e-waste exhibited an increase.

**Table 2 : Flexural Strength**

| MIX | Flexural Strength (MPa) | |
|---|---|---|
| | 7 DAYS | 28DAYS |
| Normal M-25 | 2.61 | 3.54 |
| Fly ash and E-waste mix, 10% | 2.79 | 3.94 |
| Fly ash and E-waste mix, 20% | 2.87 | 4.15 |
| Fly ash and E-waste mix, 30% | 2.69 | 3.60 |

The flexural strength results at 7 and 28 days for different replacement levels (10%, 20%, and 30%) of cement with fly ash and E-waste in concrete are presented in Table 2. The highest flexural strength of 4.15 MPa was observed in the 20% mixture.

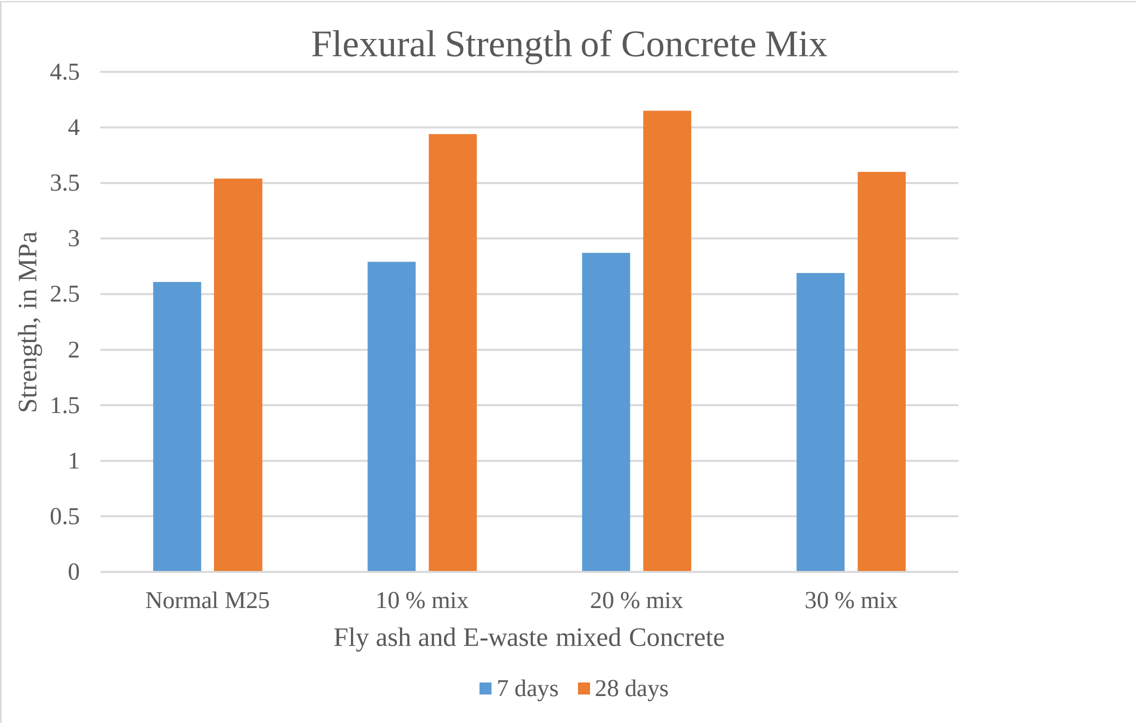


**Fig. 2: Flexural Strength**

**Split tensile strength test result**

The split tensile strength test is a common method used to determine the tensile strength of concrete. It involves applying a compressive load along the length of a cylindrical concrete specimen while measuring the tensile strength developed across a section perpendicular to the applied load. The results obtained from this test provide valuable information about the quality and performance of the concrete. In a split tensile strength test, a cylindrical concrete specimen is placed horizontally between two platens of a testing machine. The load is applied at a constant rate until the specimen fractures. Simultaneously, a transverse force is applied diametrically opposite to the applied load, causing the specimen to split apart. The maximum load at which the specimen fractures is recorded, and the split tensile strength is calculated by dividing this load by the cross-sectional area of the specimen. The split tensile strength test results are typically reported in units of force per unit area, such as megapascals (MPa) or pounds per square inch (psi). These results indicate the ability of the concrete to resist tensile stresses, which is important in structures subject to bending or direct tension. The split tensile strength of concrete is influenced by various factors, including the water-cement ratio, aggregate properties, curing conditions, and concrete mix design. Higher split tensile strength values generally indicate better quality concrete with improved resistance to cracking and durability.

**Table 3 : Split tensile Strength**

| MIX | Split tensile Strength (MPa) | |
|---|---|---|
| | **7 DAYS** | **28DAYS** |
| **Normal M-25** | 2.11 | 3.37 |
| **Fly ash and E-waste mix, 10%** | 2.72 | 4.28 |
| **Fly ash and E-waste mix, 20%** | 3.12 | 4.88 |
| **Fly ash and E-waste mix, 30%** | 2.88 | 4.34 |

In this study, a total of six cylinders were cast using different percentages (10%, 20%, and 30%) of fly ash and E-waste mixed with concrete. Additionally, two cylinders were cast using plain cement concrete. All the specimens were subjected to curing at different intervals of 7 and 28 days. The results of the study indicate that the average split tensile strength of the concrete mixture containing 20% fly ash and E-waste exhibited an increase.

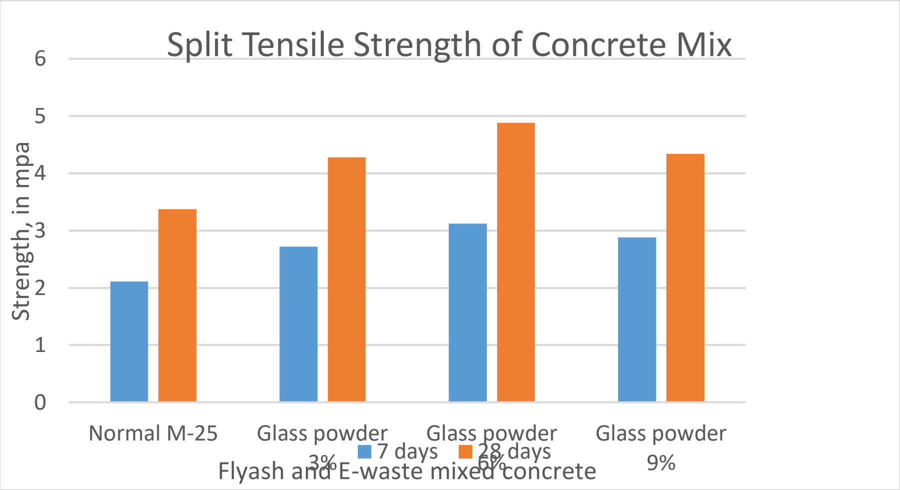


**Fig. 3: Split tensile Strength**

Table 2 presents the split tensile strength results at 7 and 28 days for various replacement levels, namely 10%, 20%, and 30%, of cement with fly ash and E-waste in concrete. The highest split tensile strength of 4.88 MPa was observed in the 20% mixture.

## CONCLUSION

The study conducted on concrete with various dosages of fly ash-based geopolymer and plastic e-waste has provided valuable insights into the potential benefits and challenges of using these materials in concrete production. the incorporation of fly ash-based geopolymer in concrete has shown promising results. It has been observed that geopolymer can effectively replace a portion of cement, leading to reduced carbon emissions and improved sustainability of concrete. The addition of fly ash-based geopolymer has also shown to enhance the compressive strength and durability properties of concrete, making it a viable alternative to traditional cement-based concrete. the study explored the possibility of utilizing plastic e-waste as a partial replacement for fine aggregate in concrete. While plastic e-waste has the potential to address the issue of waste management and reduce the demand for natural resources, the findings of the study indicate certain challenges. The addition of plastic e-waste in concrete has shown to adversely affect the workability and compressive strength of concrete. Further research and optimization of the dosages and processing techniques are required to overcome these limitations and ensure the desired mechanical properties of the concrete. In conclusion, the study highlights the positive impact of fly ash-based geopolymer on concrete properties, including enhanced strength and durability. However, the incorporation of plastic e-waste in concrete is still a complex challenge that requires further investigation. It is essential to strike a balance between sustainability and maintaining the structural integrity of concrete. Continued research and development are needed to optimize the use of plastic e-waste in concrete production, while addressing the challenges related to workability and strength. These findings contribute to the ongoing efforts in promoting environmentally friendly construction materials and sustainable waste management practices in the construction industry.

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