Study of concrete at various dosages with fly ash based geopolymer and Plastic E-waste

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Submitted by

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DECLARATION

I hereby declare that the work presented in this report entitled **“Study of concrete at various dosages with fly ash based geopolymer and Plastic E-waste”**, I carried out the action. For the award of any other degree or diploma from any other University or Institute, I have not submitted the matter embodied in this report.

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CERTIFICATE

This is to certify that the thesis entitled **“Study of concrete at various dosages with fly ash based geopolymer and Plastic E-waste”**This document is an authentic record of the research work conducted by Prateek Saxenawhile working under my supervision, and it was presented to the Rajshree Institute of Management and Technology in Bareilly as part of the requirements for a Master of Technology in Civil Engineering. The content of this thesis has not been presented in full or in part to another university or institute for a degree or diploma.

Signature

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ABSTRACT

Concrete's properties are examined in this study, along with those of concrete containing plastic e-waste and geopolymer made from fly ash at varying concentrations. The goal is to learn how the mechanical qualities, durability, and environmental performance of geopolymer concrete are affected by the addition of plastic e-waste as a sustainable component. The research is centered on the utilization of geopolymer derived from fly ash as a binder and plastic e-waste as a partial replacement for fine aggregate in concrete mixtures with varying dosages of both components. Both of these components are used in varied proportions. the evaluation of the material's structural performance, which will be based on the material's mechanical properties. To determine how long the concrete will last and how well it will hold up, we will also evaluate its resistance to chloride penetration, sulfate assault, alkali-silica reaction, and carbonation. These tests will help us determine how well the concrete will hold up and how long it will last.

The environmental performance of the concrete will be judged by a "life cycle assessment," or LCA. It will look at things like how much energy it uses, how much carbon dioxide it makes, and how many resources it needs. This study compares the environmental effects of putting plastic waste e-waste into geopolymer concrete to conventional concrete. The results of this study will tell us important things about how plastic e-waste could be added to geopolymer concrete in a sustainable way. The findings will aid in the development of environmentally friendly concrete mixtures, promote waste recycling, and lessen the negative environmental impact of building materials. The purpose of this study is to learn more about geopolymer concrete technology, evaluate the performance of concrete made from sustainable plastic waste, and make it simpler for the building industry to use sustainable plastic practices. The findings will help engineers, researchers, and lawmakers who are interested in using sustainable building materials and getting rid of waste.

CHAPTER 1

INTRODUCTION

1.1 Study Background

Concrete is mostly useful material for. Dams, bridges, skyscrapers, sewage and water systems, and public buildings—all of these and more are shaped by the design and construction of concrete. Concrete is the prototypical construction material because it is poured in a liquid state and then hardens over time, much like natural rock. Silica fume and fly ash, both by-products of the thermal industries that have a negative impact on the environment, are the two most important cement substitute materials that are currently commercially available internationally. Typically, they are substituted for cement to lessen cement use. The concrete's strength, sulphate resistance, and impermeability are all improved by using these additives. All of these qualities may be seen in fly ash.

Fly ash, with its round, smooth particles, enhances workability right out of the gate. Reduced water-to-cement ratios, made possible by the better workability, result in higher compressive strengths. Because solid fly ash is stronger and easier to work with, it could be used to speed up the curing time of concrete. After the cement reaction, there is a pozzolanic reaction to get rid of any calcium hydroxide that is left over. Over the past 10 years, the amount of fly ash made in India has gone up by almost 50%, to a total of 100 million tonnes.

Utilizing industrial and agricultural waste resources is crucial for achieving sustainable growth and producing a greener concrete material in the building sector. There are a variety of factors contributing to the unsustainable nature of today's concrete construction market. Primarily, it uses up a lot of raw resources that can be reused in the future As a second point, Portland cement is frequently employed as a glue in building projects. Carbon dioxide (CO2) is released in large amounts during the Portland cement production process, contributing to climate change and global warming. Then there's the fact that many concrete buildings have longevity issues that might be a waste of resources. So, we need to find a way to partially replace the port land cement with industrial and agricultural waste materials. Appropriate for both the here and now and the future, it appears to offer the answer to the problem of sustainable development. Co2 is reduced into the atmosphere, recycling and reusing waste materials help to safeguard the environment and reduce the amount of energy used in cement production. For other reasons, using materials with the potential for pozzolanic reactivity can greatly enhance some qualities of concrete, and this is something that is often overlooked.

Historically, mudstones from the mudstone industry were used in building projects. Fly ash is a byproduct of coal, created when coal is burnt at high temperatures in thermal plants, resulting in finely fragmented particles. Concrete's strength, workability, and other qualities can be improved by using Fly Ash, a by-product of burned coal from power plants, and other industrial and agricultural waste and mineral wastes as an additional cementations component. As a mineral byproduct of thermal power plants, fly ash consists of tiny particles that have been broken apart. Similar pozzolanic characteristics can be found in fly ash as those seen in naturally occurring pozzolanic materials. Fly ash concrete has economic and technical benefits to structural concrete, and it also has social benefits because it reduces the amount of fly ash disposed of directly into the environment and the amount of carbon dioxide emitted into the atmosphere.

These days, it's not uncommon for concrete to be made using fly ash, silica fume, and other byproducts from the manufacturing sector. In terms of health risks, electronic and electrical waste can be roughly divided into two categories: hazardous and nonhazardous. The phrase "e-waste" is commonly used to refer to obsolete, obsolete, or otherwise unusable electronic equipment. It's a major pain in the neck to clean up after all the broken electronics. Concrete is increasingly made with byproducts from other industries, such as fly ash, silica fume, and others. There are two types of electronic and electrical waste: those that pose a health risk and those that don't. Common methods of disposing of E-waste include dumping, incineration, reusing, and recycling. These methods of disposal come at a hefty price and pose risks to our environment. A recycling procedure that is both affordable and kind to the environment is a having to respond.

1.2 Cement and Concrete with Fly Ash

Concrete hard material composed of aggregates deposited in a cementitious media The construction industry's adoption of concrete has accelerated alongside the growth of concrete technology. One of the most important ingredients in concrete is cement. Coarse and fine aggregates, admixtures, and water are all utilised in the production of concrete in addition to cement. Due to its ability to bind other components together, cement is a crucial part of any concrete mix. Cement is made from limestone, sand, clay, and various oxides of aluminum.

At the high temperatures in the kiln, these oxides react with one another to produce four different complicated compounds.

The byproduct of burning coal, known as fly ash, can be used to augment cement and concrete. A smaller quantity of cement is needed to produce the same volume of concrete with the same characteristics and performance when fly ash is added. The advantages of using fly ash into cement and concrete are as follows:

Reduced cement consumption Fly ash can partially substitute cement in cement and concrete, reducing the amount of cement used and the carbon footprint.

Increased strength: Cement and concrete can have more strength in both areas when fly ash is added. This is because of the pozzolanic reaction, which happens when fly ash and calcium hydroxide mix with water to make more cement-like compounds.

Reduced permeability: Fly ash can reduce the permeability of cement and concrete, making them more resistant to water penetration and increasing their durability.

Reduced heat of hydration: it is reduce the fly ash for cement and concrete, which can be beneficial in large pours and in hot weather conditions.

Environmental benefits: Greenhouse gas emissions, landfill space needs, and the need for virgin materials are all decreased when fly ash is substituted for it in cement and concrete production.

Overall, the use of fly ash in cement and concrete can provide significant benefits in terms of strength, durability, workability, and environmental sustainability. In order to guarantee that fly ash-based cement and concrete work as expected, thorough testing and quality control are required. To further assure its safe and responsible usage, fly ash in cement and concrete is governed by rules and standards.

As a material, concrete is sturdy and resilient. If constructed appropriately, reinforced concrete may survive wood and steel in the face of storms, earthquakes, bomb blasts, and fire. Construction businesses rely heavily on concrete innovations while constructing homes, businesses, harbours, airport runways, highways, and more. Concrete is an amazing and crucial building material that has played a significant role in human development. According to Brunauer and Copeland (1964), water is the only element that humans drink in such vast quantities. There is little question that as human civilization progresses, concrete will remain a common building material. The growth of the concrete industry in the last few decades has caused a lot of problems for the environment, such as pollution, dumping of trash, gas emissions, depletion of natural resources, etc. The most important things that determine the quality of concrete are how it works and how well it holds up over time and the aggregate make up the three stages of hardened concrete. For the best results, you should pay close attention to all three stages. About 30–40% of the amount of concrete comes from hydraulic cement paste, and the other 60–70% comes from aggregates. Fig.1.1 shows the different things that make up concrete. Air also makes up part of the paste step of concrete. Most of the density of a typical concrete comes from the aggregates that are used.

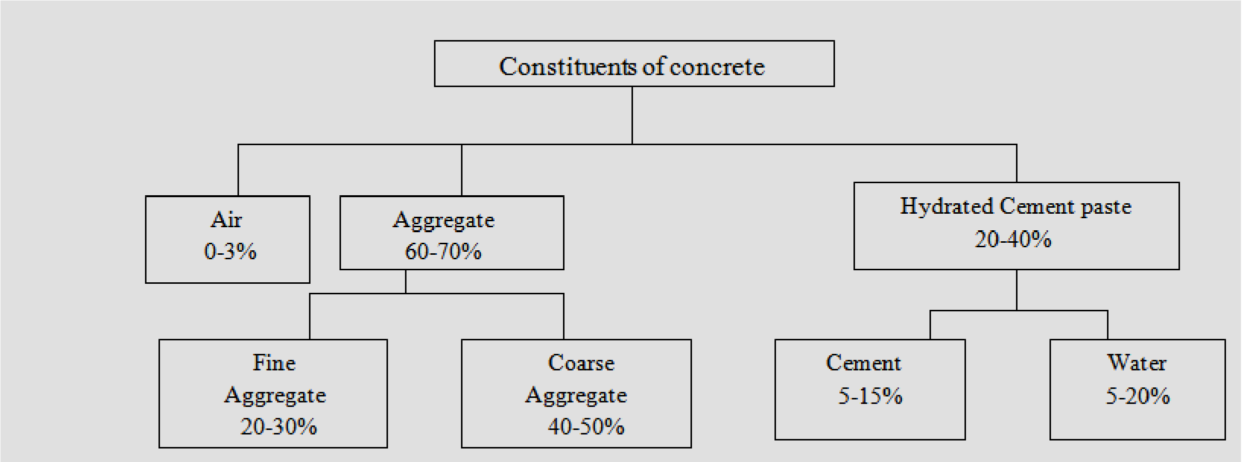
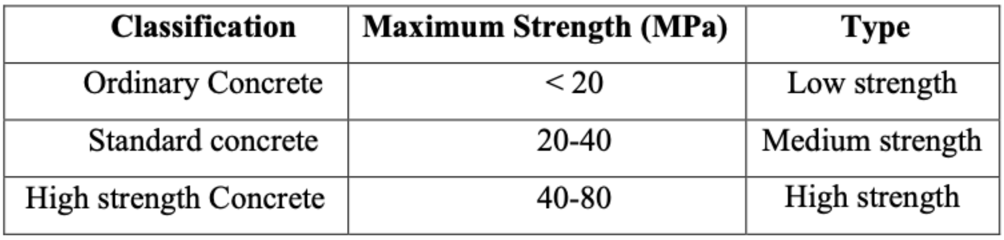


Fig. 1.1: Constituents of Concrete

Compressive strength has a significant impact on how the concrete looks. Using high compressive strength concrete (compressive strength 60–100 MPa) for the first time in the late 1970s, big building and long-span bridge construction got underway. Concrete technologists came up with high performance concrete (HPC), which is very strong and does its job well for a long time.

“Table 1.1: strength base concrete classification



Classification	Maximum Strength (MPa)	Type
Ordinary Concrete	< 20	Low strength
Standard concrete	20-40	Medium strength
High strength Concrete	40-80	High strength

The strength of concrete has a direct bearing on quality and is, thus, the most crucial feature. Due to its relation with durability and dimensional stability, strength is employed as a metric for managing and assessing other qualities of concrete. Several factors that influence concrete strength are depicted in Fig 1.2. The volume, moisture, and form of a specimen are all factors that can be used as variables.

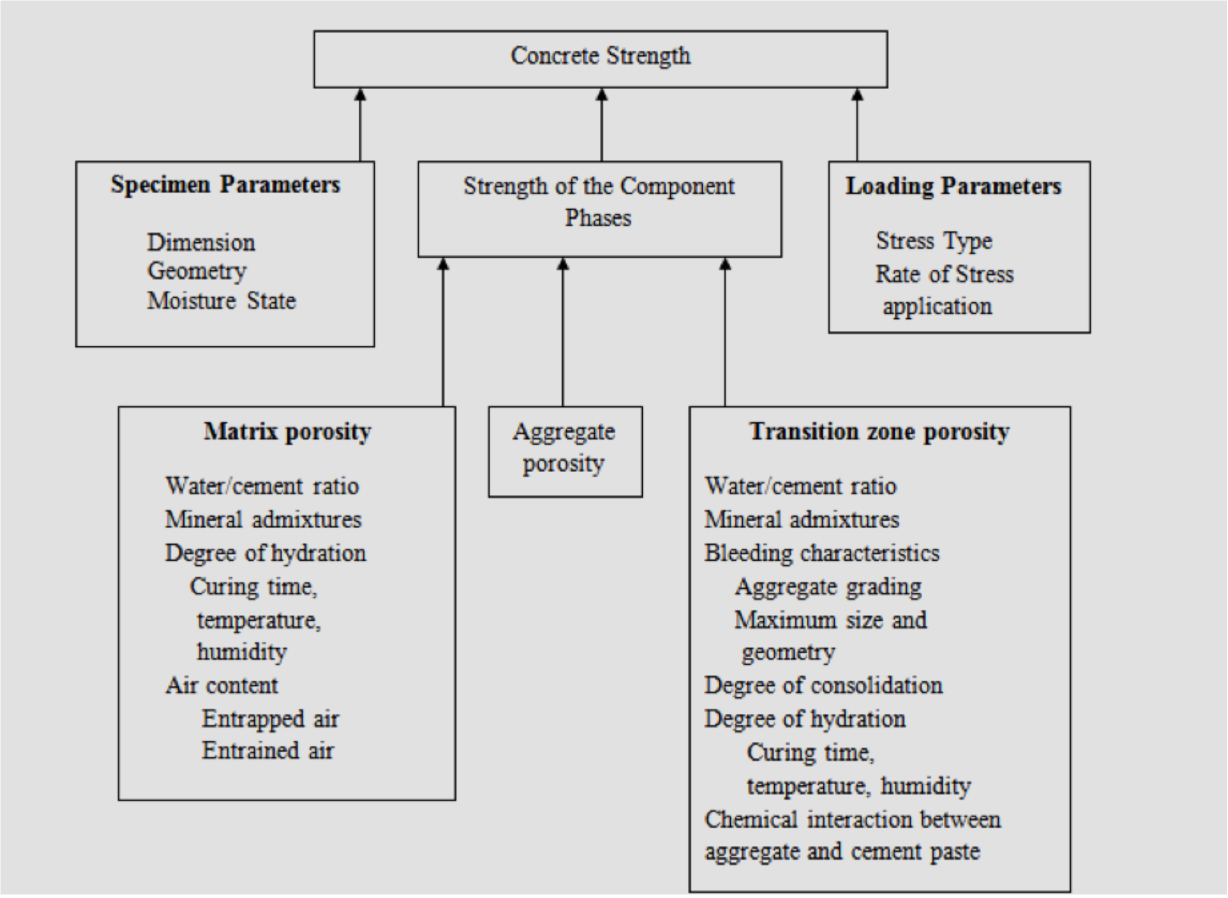


Fig. 1.2: Factors affecting the strength of concrete

Traditional concrete is a popular building material, although alternative materials are getting popular for special cases. Use prestressed, self-compacting, or fiber-reinforced concrete depending on the situation. As illustrated in Fig. 1.3, the necessity to save resources and gain maximum output from them has resulted in five primary emphasis areas of growth in the concrete industry. Many buildings nowadays are constructed in extreme environments where they must endure severe and unpredictable weather conditions. As a result, concrete durability has emerged as a critical factor in the object's development over the past few decades. In order to provide concrete new and better qualities, polymers and co-polymers are sometimes added to it.

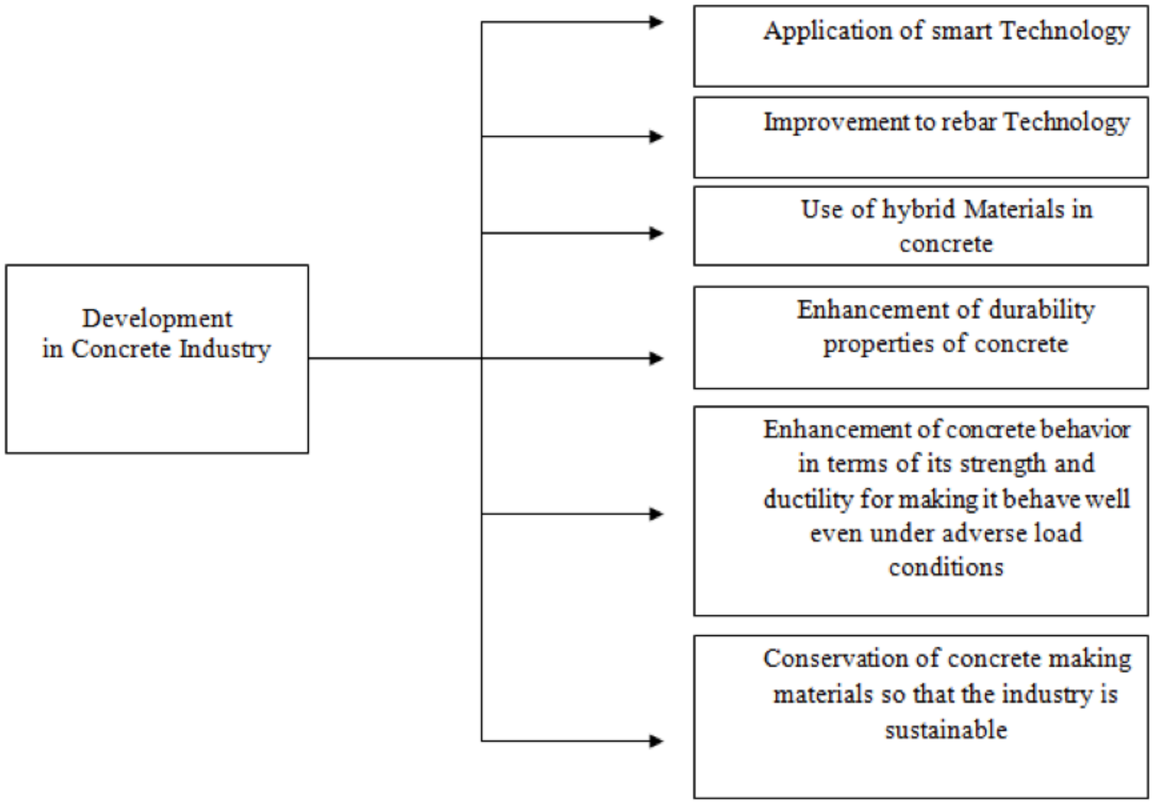


Fig. 1.3: Developments in concrete industry

1.3 Geopolymer

Geopolymer is a type of material that is made by combining an aluminosilicate material with an alkaline activator.

When the aluminosilicate material and alkaline activator are combined, they undergo a chemical reaction called geopolymerization. This reaction forms a three-dimensional network of inorganic molecules that have properties similar to those of natural minerals. The resulting material, called geopolymer, can have properties such as high strength, low shrinkage, and resistance to chemical attack.

Geopolymers can be used as a replacement for traditional materials such as concrete, ceramics, and metals. They have several advantages over traditional materials, including:

Environmental benefits: Geopolymers can be made from industrial waste materials, such as fly ash, which reduces the demand for virgin materials and reduces waste disposal requirements. They can also produce less greenhouse gas emissions during production.

High strength and durability: Geopolymers can have higher compressive and flexural strength than traditional materials. They can also exhibit better resistance to chemical attack, abrasion, and fire.

Low shrinkage: Geopolymers can have lower shrinkage than traditional materials, reducing the risk of cracking and improving long-term durability.

Rapid setting: Geopolymers can set and harden more quickly than traditional materials, reducing the time required for construction and reducing the risk of damage due to premature traffic or loads.

Geopolymers are still a new and developing technology. More study and development are needed to improve the technology and find solutions to the problems it faces. But they could be a more sustainable and high-performing option to traditional materials in a number of situations.

1.4 Environmental concerns

Concrete has one of the lowest amounts of energy built into it of all engineering products, causes of environmental damage. About 5–8% of all CO2 emissions come from the cement business alone. The amount of resources used as a whole is also a role. Concrete will be used a lot in the 21st century, and the total amount used is likely to go up. In 2015, the G20 countries that made the most cement made about 3.5 billion tons, which was used to make about 10 billion cubic meters of concrete. This is mostly because most materials lose their value and aren't used as raw materials once their useful lives are over. However, there is great opportunity for the concrete sector to make a good transition toward a more sustainable circular manufacturing model and a smaller overall environmental impact. Making use of by-products and scraps from other sectors as concrete's raw ingredients is one approach. Concrete is an amazing and crucial building material that has played a significant role in human development. There is little question that as human civilization progresses, concrete will remain a popular building material. have been introduced by the growth of the contemporary concrete industry. Portland cement and other cementitious ingredients are the most cost-effective binders available today that also maintain and improve concrete's function. However, Portland cement manufacture uses the most energy and results in the most CO2 emissions among these binders. On the other hand, the Kyoto Protocol of 1997 established a global resolve to a cut of 8% in greenhouse gas emissions by 2010. The developed nations are well aware of the importance of this and have implemented a climate change tax. For similar reasons, the government of the United Kingdom enacted a similar tax on the first of April 2001, with the aim of reducing greenhouse gas emissions by 12.5% and therefore meeting its domestic objective of a 20% reduction in CO2 emissions by 2010.

As the most common man-made material and one of the most important building components, cement-based materials would undoubtedly maintain their current level of importance. On the other hand, these building and engineering supplies need to be up to date with the latest standards. Competing with alternative construction materials like plastic, steel, and wood means addressing concerns of productivity, economics, quality, and the environment. However, for ecological reasons, it is critical that a sustainable concrete be developed. Cement, the main component of concrete's binder, is widely acknowledged to have a significant effect on the environment. Presently, cement manufacturing accounts for around 10% of all anthropogenic CO2. Today, nature serves as a primary source of inspiration for innovation because of its proven track record as a sustainable alternative. The concrete industry's unsustainable practises mostly stem from the material's high carbon footprint. The binder in concrete, cement, has been found to have serious consequences for the natural world. For every ton of cement produced, there is an equivalent amount of carbon dioxide released. Several pledges have been made to minimise this through various frameworks since the Kyoto Protocol-

(i) “Production efficiency,

Numerous studies are now being conducted to lessen the environmental effect of concrete, with the goal of achieving maximum sustainability. for example:

The enormous quantities of concrete utilised are another contributor to the substance's high carbon footprint. Because of this, establishing ideal strengths allows for a decrease in the volume of concrete needed to achieve the same results. Plasticizers are additives that allow for a greater range of workability at lower water contents. However, the only thing stopping us from falling lower this ratio is the workability of the concrete. In order to reduce CO2 emissions from concrete, researchers are also exploring the possibility of using cements other than Portland clinker. Or, if slag is used in lieu of the clinker, an alkali can indeed be added to make it work. However, it is becoming increasingly clear that more and more aggregates are reactive, making Alkali-Silica reactions a more pressing issue. Cracks can occur and concrete can deteriorate with time. Given that cement paste is the most porous component, it has been discovered that decreasing the cement content by 20% enhances durability. Therefore, employing less cement produces better concrete because cement is what allows exposed components to enter and exit the structure. Corrosive substances like chlorides and sulphates attack the metal reinforcement of reinforced concrete through the material's pores, which account for over 90% of durability problems. However, concrete's ultimate strength comes before long-term CO2 reductions.

About 7% of annual worldwide carbon dioxide emissions come from the world's 1.6 billion tonnes of cement manufacturing. Portland cement, the most widely used hydraulic cement today, is also a significant contribution to global warming due to the energy it requires and the pollutants it creates.Deforestation and topsoil loss are also common outcomes of the mining of bulk amounts of raw minerals like limestone, clay, and fuel sources like coal. Common concrete has a concrete concentration of around 12% to 80%. Fresh water is also consumed in significant quantities by the concrete industry; only the mixing water need is estimated to be over 1 trillion litres annually. Although accurate numbers are unavailable, it is known that the ready mixed concrete industry uses vast volumes of fresh water as wash-water and for curing concrete. Other than cement, aggregates, and water, concrete also includes a wide variety of chemical and mineral admixtures.

By using less raw materials and less energy in the production of concrete while simultaneously increasing the longevity of concrete goods, the concrete industry may increase its resource productivity and lessen its negative effect on the environment. The job is really difficult, but it is doable with persistence. The first step in lowering energy use and GHG emissions is conserving cement. We need to reduce our use of portland cement to fulfil rising demand for concrete while still maintaining a high level of resource efficiency. For the concrete industry to thrive, this is the most pressing issue that must be addressed immediately. Since resource optimization rather than labour productivity is the primary objective of an industry, a small delay in the building schedule is likely to be acceptable for the majority of structural applications.

1.5 Fly ash

Sustainable green materials has gained a lot of attention in the construction and building material areas over the past several decades because of their potential to reduce the need for quarrying limestone for cement production. Massive cement production, that has been pushed by the rising need for both residential and industrial construction, is a major contributor to rising CO2 levels. It was believed that as much as 7% of the world's CO2 output was released by the cement industry [1]. To alleviate this problem, it is essential to employ additional cementitious materials.

The large quantities of coal fly ash (FA) generated by thermal power stations form an ideal complement to POC aggregate, which can mitigate air pollution and disposal problems [7]. Because of its capacity to cause widespread air and water pollution, FA is a waste item which may cause disposal and environmental degradation issues [8]. By reducing the amount of fly ash trash disposed of and the amount of cement used in concrete production, using this industrial waste as an ingredient will help to create a cleaner environment [9]. To date, using FA as a cement replacement in tiny amounts has resulted in concrete with respectable mechanical and durability characteristics [10]. Due to differences in fly ash characteristics that are established by its origin and the way a power plant is run, its usage is restricted to no more than 20% [11].

What we call "fly ash" is essentially the inert mineral fraction of coal. Coal is often powdered before being burned in a power plant. Carbon is burned off in the boiler of the power plant, leaving particles rich in silica, alumina, and calcium that have been blown in. The name "fly ash" comes from the fact that the particles form into tiny glassy spheres in the exhaust of power plants before they can escape.

By reacting with free lime, fly ash can create the same cementations chemicals that result from the hydration of Portland cement through a process known as pozzolanic activity. Fly ash concrete experiences a slower rate of strength growth at younger ages of curing than conventional concrete does because of this chain of chemical reactions. Pozzolana Portland cement, a type of cement made from fly ash, has gained some traction in recent years, although total percentage usage remains relatively low, and most fly ash is discarded at landfills.

Fly ash is a glassy powder that is salvaged from the fumes produced when coal is burned to generate electricity. As a byproduct of their operations, power plants generate millions of tons of fly ash annually, the vast majority of which is disposed of in landfills. There is no loss in compressive or tensile strength when using fly ash as a replacement for Portland cement in concrete. Brick, blocks, pavement, and structural reinforcements can all benefit from using fly ash as a material.

1.5.1 Classification of fly-ash

Class F and Class C fly ash are the two most common types. Both exhibit identical bodily responses. The "pozzolanic reaction" between Class F and Class C fly ashes and lime (calcium hydroxide) formed during cement hydration with water yields the same binder (calcium silicate hydrate) as cement. Its chemical and physical qualities are often used to categorize it, and these can change depending on where the coal was mined and how it was burned.

Here are some common classifications of fly ash:

A byproduct of burning coal in thermal power plants is fly ash. It is frequently used to fortify cement in the building sector. To comprehend the features and uses of fly ash, it must first be divided into a number of classes based on a range of factors. Fly ash is classified into distinct classes based on its chemical composition, appearance, and manufacturing method. The chemical composition of fly ash influences how it responds and what it can be used for.

Fly ash fineness and particle size distribution can be categorized in terms of physical qualities. The amount of fly ash that fits through a particular sieve size, like 45 or 90 microns, is typically used to measure fineness. Fly ash with a higher fineness tends to be more reactive and have better pozzolanic properties. The size distribution of the particles is another important element because it affects how easy concrete is to work with and how strong it gets over time. Most of the time, fly ash with a narrower particle size distribution works better.

Class F: Anthracite or bituminous coal is commonly burned to create Class F fly ash, which has a low calcium oxide level (less than 10%). It helps make concrete more workable and uses less water during production.

Class C: Class C fly ash has a calcium oxide level of 10% or higher and is typically generated from the combustion of lignite or sub-bituminous coal. It is commonly used to increase the durability and strength of concrete.

Class N: Class N fly ash is a new classification that was introduced in recent years. It is produced from burning a mixture of coal and other materials, such as biomass, and has properties that fall between Class F and Class C fly ash.

1.5.2 Properties of fly-ash

Mechanical dust collectors and electrostatic precipitators separate the fuel gases from the resulting fly ash or crushed fuel. The burning fuel, boiler load, and kind of separator all affect the chemical make - up of fly ash. Fly ash, like Portland cement, is composed of calcium, aluminum, and silicon oxides, albeit the quantity of the former is much less. Both the carbon and the silica levels should be optimized to be as low as feasible and as high as possible, respectively. Fly ash mineralogy and fly ash practical size are two factors that can be used to characterize the substance.

Fly ash, a byproduct of burning coal, can be used as an additive to cement to make concrete. Fly ash is a byproduct of coal combustion, and its characteristics can shift based on the type of coal used and how it was burned. Below are some of the more universal characteristics of fly ash:

“Particle size: Fly ash particles are typically very fine and range in size from 0.5 to 100 micrometers.

Chemical composition: Fly ash is composed primarily of silicon dioxide, aluminum oxide, and iron oxide, as well as smaller amounts of calcium oxide, magnesium oxide, and other compounds.

Pozzolanic activity: Fly ash has pozzolanic activity, meaning that it reacts with calcium hydroxide in the presence of water to form additional cementations compounds, such as calcium silicate hydrate.

Color: Fly ash can range in color from light tan to dark gray, depending on the source of the coal and the combustion process.

Specific gravity: Fly ash has a relatively low specific gravity, typically ranging from 1.9 to 2.6.

Strength development: Fly ash and calcium hydroxide undergo a pozzolanic reaction that, over time, raises the concrete's compressive and flexural strengths.

It is important to note that the properties of fly ash can vary depending on the specific source and processing method used. Therefore, proper testing and quality control are essential to ensure that the fly ash being used in concrete production meets the desired performance specifications”.

1.6 Fly Ash Based Geopolymer and Plastic E-waste

Fly ash based geopolymer and plastic e-waste are two innovative materials that can be used in concrete production to reduce environmental impacts and improve the sustainability of construction practices.

A form of geopolymer concrete, fly ash based geopolymer is made from fly ash instead of traditional cement. The use of fly ash, a byproduct of burning coal, can lessen the amount of cement required and so cut down on emissions of greenhouse gases during the making of concrete. It is possible for geopolymer concrete made using fly ash to have more compressive strength and durability than concrete made with Portland cement.

Plastic e-waste is another innovative material that can be incorporated into concrete. E-waste refers to discarded electronic devices, and plastic e-waste can be recycled and added to concrete as a partial replacement for traditional aggregates. This can reduce waste and improve the sustainability of construction practices.

Geopolymer made from fly ash and plastic e-waste can help the earth even more when they are combined. Using both of these things in concrete can cut down on the amount of trash that ends up in dumps and the need for new materials. Also, fly ash-based geopolymer can make the concrete stronger and last longer, and plastic e-waste can improve the concrete's mechanical qualities.

Additionally, proper testing and quality control are essential to ensure that concrete made with these materials meets the desired performance specifications.

1.7 Effect of use of fly ash in concrete

When fly ash is added to concrete, it changes many things about the material, such as its strength, durability, workability, and ability to last. Adding fly ash to cement as an extra cementitious material has a number of good effects. The compression strength of concrete is increased by the use of fly ash. It is used as a filler material to make the concrete mixture more dense. Fly ash can combine with calcium hydroxide in the presence of water thanks to its pozzolanic properties, resulting in the formation of new cement-like compounds. Over time, this process causes the concrete matrix to become stronger and denser. In concrete, fly ash reduces the heat of hydration. During the hydration process, cement gives off heat, which can cause big concrete structures to crack due to thermal stress. In order to improve thermal performance and lower the risk of cracking, the presence of fly ash helps to lower the total amount of heat produced. The durability of concrete is increased by adding fly ash. It reduces the permeability of the concrete matrix, making it less likely that harmful substances like chlorides and sulfates will get inside. In turn, this makes concrete more resistant to chemical attacks, corrosion of the support, and damage caused by freezing and thawing.

Also, using fly ash in concrete helps make building methods that are better for the environment. By using fly ash to replace some cement, the need for regular cement is cut down. This cuts down on the amount of carbon dioxide released when cement is made and helps keep natural resources from running out. Fly ash, which is a waste result of burning coal, is used well, so there is less need to put it in a landfill. In addition, fly ash makes concrete easier to work with. Because the particles are small and round, it works as a lubricant, making it easier for the concrete mix to flow and be placed. This makes building easier and makes the concrete easier to work with in general. The use of fly ash in concrete has a number of positive effects. It increases the compressive strength, reduces the heat of hydration, increases the durability, helps the material last longer, and makes it easier to work with. Because of these benefits, fly ash is a valuable and widely used supplementary cementitious material in the building industry. This helps make better use of resources and more environmentally friendly ways to make concrete.

1.8 Geopolymer concrete

Geopolymer concrete is a type of concrete that isn't held together by Portland cement. Most geopolymer binders are made from industrial waste like fly ash, slag, or rice husk ash. An alkaline solution is used to make them work. The resulting concrete can have the same or even better properties and performance than traditional concrete made with Portland cement.

Environmental benefits: Geopolymer concrete can use industrial waste materials as a feedstock, reducing the demand for virgin materials and reducing waste disposal requirements. It can also produce less greenhouse gas emissions during production.

High strength and durability: Geopolymer concrete can have higher compressive and flexural strength than traditional concrete. It can also exhibit better resistance to chemical attack, abrasion, and fire.

Low shrinkage: Geopolymer concrete can have lower shrinkage than traditional concrete, reducing the risk of cracking and improving long-term durability.

Rapid setting: Geopolymer concrete can set and harden more quickly than traditional concrete, reducing the time required for construction and reducing the risk of damage due to premature traffic or loads.

However, geopolymer concrete also has some challenges that need to be addressed for wider adoption. These include:

Lack of standards: There is currently no standard specification for geopolymer concrete, making it difficult to ensure consistent quality and performance.

Limited availability of raw materials: The availability of suitable industrial waste materials for geopolymer concrete production can be limited in some regions.

Higher initial cost: The initial cost of producing geopolymer concrete can be higher than traditional concrete due to the cost of the raw materials and the need for specialized equipment.

1.9 E-waste

Disposal of E-waste is a common chore in many parts of the world. The disposal of electronic trash in landfills results in the release of toxic leachates that seep into the earth and contaminate the groundwater. Congealed computer chips contain acids and sludge that, if disposed of on the ground, would form sulfuric acid the soil. Recovering electronic trash can help alleviate some ecological and environmental issues. In this project, we recycle electronic trash by using printed circuit boards.

In recent years, there has investigation into the potential of electronic waste to improve the characteristics of concrete. As a result of the wide variety of materials and components used in their creation, as well as the complexity of the manufacturing process, WEEE is a high variability and complicated waste stream. The absence of recycling Humans and the ecosystem are in grave danger from the pollution caused by trash. Therefore, it is important to think of other, more efficient methods of waste management. In the concrete business, people have tried using non-biodegradable E-waste components as a substitute for either the coarse or fine aggregates. Recent decades have seen an uptick in the usage of electronic waste from a variety of sources as a replacement for cement, fine and coarse aggregate, and other components of concrete. Because of environmental regulations on their proper disposal, these items are increasingly being used in concrete production. The use of E-waste materials in cement, concrete, and other building materials has several immediate benefits, including the reduction of cement and concrete manufacturing costs and the saving of energy and the prevention of environmental damage caused by landfill trash.

Printed circuit boards have recently been considered as a potential replacement for aggregate in concrete due to their ability to increase air content, enhance water retention properties, and decrease bulk density in hardened mortar.

Every year, millions of tonnes of electronic garbage are produced, mostly from outdated computers and other gadgets. There are thousands of different substances and chemicals in e-waste, and they can have severe impacts on human and environmental health if not disposed of properly. Heavy metals like lead, cadmium, mercury, arsenic, selenium, hexavalent chromium, etc. are only a few examples of the many toxic substances that are widely used. are also found in discarded electronic equipment. In most dumps, electronic trash accounts for around 70 percent of the mercury and cadmium found there. The majority of the lead found in landfills comes from consumer electronics. In addition to triggering allergic responses and cancer, these poisons have been linked to permanent brain damage. Gold, copper, and other common metals may be found in abundance in discarded electronics.

Every year, the globe generates over 50 million tonnes of electronic garbage. An estimated 1, 46,180 tonnes of electronic garbage is produced each year in India. Since electronic equipment sometimes includes harmful pollutants like lead, cadmium, Beryllium, etc., its processing in underdeveloped nations often results in major health and pollution issues.

Because of environmental regulations on their proper disposal, these items are increasingly being used in concrete production. Cement, concrete, and other building materials that incorporate E-waste components provide a number of indirect benefits, including but not limited to cheaper costs associated with cement and concrete production, reduced expenses associated with landfilling, and reduced environmental harm.

Fig. 1.4: E-waste

1.10 Need for Research

One of the most common building materials is concrete. Concrete is used to build dams, bridges, skyscrapers, water and sewage systems, and public buildings, among other things. Concrete seems to be the prototypical building material since it is poured in a liquid state and then cures over time, much like natural rock.

The use of fly ash based geopolymer and plastic e-waste in concrete is a relatively new and developing technology, and there is a need for further study in several areas. Here are some of the areas where additional research is needed:

Optimal mix design: The best way to mix fly ash-based geopolymer and plastic e-waste to make concrete is not yet well-known. More study needs to be done to figure out the best amounts of these materials to use to get the results we want.

Mechanical properties: To fully understand the mechanical features of concrete made with e-waste and geopolymers made from fly ash, more research needs to be done. In this way, you can figure out the concrete's compression strength, its flexural strength, and how long it will last.

Long-term performance: We don't know much about how concrete made with a geopolymer based on fly ash and plastic e-waste will work in the long run. More study is needed to find out how well these materials hold up over time, especially in harsh environments.

Environmental impact: Even though using fly ash-based geopolymer and plastic e-waste in concrete can help the environment in a big way, more research is needed to fully understand how these materials affect the environment over the course of their life cycle. This can include looking at their carbon output and how they might affect the quality of the water and the health of the soil.

Practical applications: The practical applications of fly ash based geopolymer and plastic e-waste in construction are still being explored. Further research is needed to identify specific applications and evaluate the feasibility and economic viability of using these materials in practice.

Overall, the use of fly ash based geopolymer and plastic e-waste in concrete has the potential to provide significant environmental benefits and improve the sustainability of construction practices. However, the technology and the obstacles it faces need more work before the resulting concrete can be used in any realistic setting with satisfaction of performance requirements and sustainability of cost.

1.11 Objectives of study

1. “To study the strength of concrete at various dosages when mixed with fly ash and E-waste in a definite proportion.
2. To determine the fresh properties of concrete by slump cone test.
3. To evaluate the Compressive strength, Flexural strength, Split tensile strength of concrete of grade M25 with replacement of cement with fly ash and Coarse aggregate with E-waste in proportion of 10%, 20% and 30%”.

CHAPTER 2

LITERATURE REVIEW

2.1 LITERATURE REVIEW

Partheeban, P., Kalaiyarrasi, A. R. R., et al,(2021) By totally substituting Manufactured sand (M-Sand) and Electronic Waste for River Sand, this study aims to reduce concrete's carbon footprint and evaluate geopolymer concrete's performance (E-waste). Geopolymer concrete's cementitious material can be a variety of mixtures of fly ash and Ground Granulated Blast Furnace Slag (GGBFS). By totally substituting E-waste and M-sand at varying percentages for fine aggregate, geopolymer concrete is able to achieve its signature strength. Researching the material's physicochemical and mechanical properties allows for the determination of the best replacement percentage. This experimental study's findings are in close agreement with Indian concrete specifications.

Verma, P., Dhurvey, P. et al,(2022) Carbon dioxide emissions can be reduced by using alternative binders for concrete, In this project, geo polymer concrete is made from a mixture of metakaolin and class-Fly ash. Both are good sources of alumino-silicates, which the material needs to do its main job as a binder. E-waste plastic (EWP) is hard to get rid of, so concrete mixes have been made with a small amount of crushed EWP instead of traditional aggregates to reduce the damage the material does to the environment. When making concrete, an alkaline solution of sodium hydroxide (NaOH) and water glass solution (sodium silicate) is used to activate the raw materials and make mixing easier (Na2SiO3). Low molarity metakaolin geopolymer concrete (MGPC) works better, lasts longer, and has better dynamic properties than traditional cement concrete.

Sundar, M. L., & Raj, S. (2017) Concrete is the material of choice for building around the globe. Historically, concrete's binder of choice has been ordinary Portland cement (OPC). The production of OPC involves substantial carbon-dioxide (CO2) emissions due to the burning of fossil fuels and the degradation of limestone. The majority of the warming of our planet can be attributed to this CO2 release. Geopolymer technology was made so that this wouldn't happen as much. Electricity and electronics have become so important to modern life that we can't live without them. They make our lives easier and more handy in many ways. Due to how quickly technology changes, electronic equipment is one of the waste streams that is growing the fastest around the world. This waste stream is made up of electrical and electronic items that have hit the end of their useful lives. The European Union (EU) calls this new kind of trash WEEE (Waste Electrical and Electronic Equipment). Even though WEEE isn't described by name in India's environmental laws, it is often called "E-waste."

Bhushan V. Mhatre et al, (2020) The world urgently needs to cut its emissions of greenhouse gases like carbon dioxide. The cement sector is responsible for 5%-8% of the world's total CO2 emissions. It is well recognized that the production of Geopolymer concrete results in an 80% reduction in CO2 gas emissions compared to that of traditional Ordinary Portland cement. Furthermore, Maharashtra produces the most E-waste in India, totaling 20,270 tonnes per year. This includes both electronic garbage and electrical equipment. As a result, it is a newly-emerging concern that poses significant pollution hazards to both humans and the environment. In order to boost its property compressive strength and also minimize greenhouse gas (CO2), this study investigates the feasibility of utilizing the non-metallic components of E-waste in concrete as coarse aggregates.

Chandan Kumar , Priti Kumari et al,(2020) E-waste is a worldwide issue that every nation must address. As the global population increases, so does the demand for electronic products, compounding the difficulty of properly disposing of e-waste. Landfilling is the most efficient technique of e-waste disposal; however, this approach requires a lot of space, which is increasingly hard to come by. To that end, the idea of using e-waste to partially substitute aggregate in concrete is a brilliant one. There is no suitable substitute since aggregate gives concrete its strength, durability, and workability. By considering the quantity of aggregate needed to produce concrete, it becomes clear that e-waste might be used as a viable substitute; doing so would be extremely beneficial in lightening the load on the planet's natural resources. Our experiments have included substituting electronic garbage for aggregate. We compared the compressive strength of concrete cubes cast with 4, 8, 12, and 16% e-waste to those cast with regular G30 concrete. Our findings indicate that the compressive strength of cubes first increases when e-waste is added, but then decreases when a certain threshold has been reached.

G. Gayathri ,V.S. Ramya et al,(2016) Polluting the environment is the world's most pressing issue right now. Geologically-based polymer concrete In this research, Portland cement is swapped out for fly ash and GGBS to create geo-polymer concrete (Ground granulated blast furnace slag). The activation of these materials is accomplished by using alkaline solutions. Sodium hydroxide is taken into consideration at a molarity of 8M. Ninety percent of the fly ash and ten percent of the In this study, GGBS were used. E-waste, which is short for "electronic garbage," is one of the waste sources that is growing the fastest around the world. This is mostly because of how quickly technology changes and how quickly old tools become useless. The main goal of this study was to look at how adding E-Waste to geopolymer concrete changed its dynamic properties. Also, we need to do everything we can to get rid of the huge amount of old and useless electrical and computer devices.

Abinaya, R., Nivethitha, G. U. et al,(2021) The concrete's compressive and flexural strengths are compared to those of conventional concrete and concrete made with varied percentages of e-waste and fly ash. There is no part of the concrete that fly ash doesn't affect. It's multipurpose properties allow it to function in the composite concrete mass as both a fine aggregate and a cementitious component. Concrete's strength, durability, and resistance to chemical attack are all enhanced when fly ash is added to the mix. Its use is also good for the planet. The characteristics of the resulting fly ash are dependent on the kind of coal that was burned to create it.

Dave, S., Bhogayata, A. et al,(2017) Plastic is well recognized as one of the most used materials worldwide. The rise of the chemical industries in tandem with the advent of the factory system in the nineteenth century was a major factor in the meteoric rise of the plastics industry. Although while plastic has many positive attributes, it is a material that is notoriously difficult to dispose of. Tons of plastic debris are currently drifting aimlessly throughout the world, posing a threat to ecosystems everywhere it settles. If we want to maintain a sanitary and healthy environment, we must ensure the proper management and disposal of plastic trash. Plastic trash could be used as a building material to help create a more sustainable world. As the second largest contributor to carbon dioxide emissions after the automobile, cementitious concrete is one of the energy-intensive materials that deserves our attention as we search for a suitable replacement. In recent decades, an alternative to cement-based concrete has emerged: geopolymer concrete, which is made from industrial wastes like fly ash and an alkaline activator.

Manikandan, M., Arul Prakash et al,(2017) Managing solid waste, and in particular E&E trash, is one of the most rapidly expanding waste management industries worldwide (WEEEs). Compressive and flexural strengths, as well as corrosion and alkali attack resistance, are all improved in concrete manufactured from electronic waste compared to traditional concrete. This study's fundamental objective, then, is to see if electronic waste may be used as a substitute for traditional cement in the production of low-cost concrete for use in civil engineering.

M. Sabarinathan et al,(2022) When sodium silicate and sodium hydroxide are combined in the appropriate proportions, an alkaline liquid results. After about 5 minutes, an alkaline liquid solution was produced by adding water to solid sodium hydroxide that had been sitting there. After that, a solution of sodium silicate was added to the mixture so that it could be thoroughly combined. This liquid had been prepared the night before, prior to the beginning of the mixing process. In various applications, such as precast units, ordinary Portland cement (OPC) concrete can be replaced with geopolymer concrete, which makes use of fly ash. The technology of geopolymers makes it possible to cut down on emissions of greenhouse gases and minimize the amount of money spent on getting rid of garbage from industries. In this study, we investigate the research on the impacts of recycled aggregate on the properties of geopolymer concrete both when it is new and after it has hardened. The beams were made with the best mix, and both hardened and fresh concrete was used to test their power and durability.

Bhikshma, V., KOTI, R. M. et al,(2012) By substituting geopolymers for cement, one approach to making greener concrete is to reduce the amount of OPC used. About 2.5 cubic meters of premium Geopolymer concrete may be produced from 1 tonne of fly ash. Experiments have shown that Geopolymer concrete made with fly ash has exceptional acid resistance and outstanding Compressive strength, extremely low drying shrinkage, and very low creep. The fresh and hardened qualities of the concrete used in the trial mixtures were recorded. Concrete has been found to have very good workability in terms of slump and compacting factor. It was found that freshly mixed geopolymer concrete had a high viscosity and was easy to deal with. The compaction factor was 0.95, and we saw collapsed slump.

Panda, B., & Tan, M. J. (2018) New features of geopolymer mortar created for 3D concrete printing are presented in this paper. As opposed to the time-consuming and labor-intensive process of traditional casting, 3D printing only requires the deposition of extruded materials in successive layers to create complex architectural and structural components. A concrete gantry printer is utilized to print a freeform structure that is 60 centimeters in height utilizing five different geopolymer mix designs in a systematic experimental manner to evaluate the formulation. To that end, low-carbon-dioxide (CO2) binders are required, or else by-products from various industries, such as fly ash, slag, etc., can be repurposed to create novel binders like geopolymer.

Jayarajan, G., & Arivalagan, S. (2021) Toxic degradation of the environment is the most pressing problem nowadays. Emissions of pollutants into the air are mostly caused by the manufacturing of Portland cement for use in building. By incorporating recycled materials and industrial waste into our construction processes, we want to reduce our negative effects on local air quality. A recent study has investigated the production of geopolymer concrete using alternative materials and additives. The research indicates that fly ash and Ground Granulated Blast-Furnace Slag (GGBS) can replace geopolymer cement in the manufacturing process. Furthermore, fine gravel is substituted with quarry sand and M.Sand, while smaller aggregates (10 mm) are used instead of coarse aggregates (20 mm). To bind the components together, alkaline liquids such as NaOH and Na2SiO3 are employed, inducing polymerization. The inclusion of fly ash and GGBS in the cement production process offers environmental benefits by reducing the emission of carbon monoxide and greenhouse gases. The study's findings reveal that incorporating more GGBS can enhance the overall properties of both plain and hardened fiber-reinforced geopolymer concrete mixes. Notably, the addition of reinforcing fibers significantly improves tensile, compressive, bending, and breaking strengths.

Kishore, G. N., & Gayathri, B. (2017) The use of concrete in infrastructure and transportation projects has had a significant impact on the rate of economic development and people's standard of living. Even though OPC has been used a lot in construction for many years. causing the cement business to be a big source of greenhouse gases. Davidovits started working on improving geopolymer cement in 1984 and did so until 2008. Geo polymer is a material made of alumino silicate that holds things together. Thanks to geopolymer technology, cement concrete can use less Portland cement. Fly ash, which is high in alumina and silicate, can be used instead of conventional Portland cement in geopolymer concrete because it has the same pozzolanic properties. Fly ash is a common result of burning coal that could be harmful to people's health all over the world. This makes a gel that binds the fine and coarse particles together, making a hard, compacting bonding material. This material is well-designed and holds up well in harsh situations, which are both good things.

Ryu, G. S., Lee, Y. B. et al,(2013) SEM and EDS analysis of the structure showed that Al and Si components had a major impact on the mortar's structure. The XRD findings showed that the intensity did not vary significantly across the spectrum of alkaline activators despite the fact that their chemical compositions varied widely. In contrast, the FT-IR analysis revealed distinct differences in the chemical composition of SiAOASi and SiAOAAl between fly ash and cured mortar. We were able to indirectly confirm, through a measurement of porosity, Polymerization can be activated according to the chemical components of alkaline activators, leading to improved mechanical performance.

Sapehiya and Kumar (2020)We looked into whether FA and PWF could be used in concrete as cement replacements and additions, respectively, to lower the cost of building with concrete and solve the disposal problems that come with FA and PWF. In this study, M20 grade concrete is used as a place to do experiments. FA is added into the cement in amounts of 0%, 5%, 10%, and 15% (by weight). All of the concrete mixes kept a water-to-cement ratio of 0.5. 48 pieces of 150mm*150mm*150mm and 300mm*150mm concrete were made so that the compressive and split tensile strengths of the concrete could be measured. When FA substitutes 10% of the cement, the compressive and split tensile strengths are at their best for additions of 0.5%, 1%, and 1.5% PWF. Also, when FA is used instead of cement, the concrete that is made is much more flexible.

Bouaissi et al. (2020) offered an overview of the usage of fly ash as both a primary material in geopolymer. Fly ash allows for the realisation of superior mechanical qualities as a result of its plentiful supplies, relatively inexpensive, exceptional workability, and superior physical properties. In countries like China, India, and the United States, where it is produced in enormous quantities, fly ash is well recognised as a major source of industrial solid waste. Fly ash has the properties needed to be used as a geotechnical material in the manufacture of geopolymer cement or concrete in place of regular Portland cement. Fly ash is the primary focus of several efforts to develop a viable mix design for a geopolymer built mostly from this byproduct. In this survey work, researchers examine and assess the physical characteristics, chemical compositions, and chemical activation of fly ash. Different ASTM standards, ACI guidelines, and other geopolymer-related studies have been referenced.

Ariff et al. (2019) They looked at how long fly ash-mixed concrete would last to see if it could be used in place of cement and as a mixing aid. The amount of cement that is replaced with fly ash is looked at in connection to how strong the concrete is. After 21 days, samples with 10, 20, 30, 40, and 50% cement replacement are put through tests in the lab. Samples of concrete that has been mixed with fly ash are tested for their pliability, tensile strength, compressive strength, and shear strength. The same tests are done on a control group of concrete without any fly ash. The results are then compared to find out how much fly ash can be added to the mix without hurting the quality of the concrete.

Divya et al. (2019) showed what happened when fly ash (0-30%) was added to concrete. Fly ash is a type of trash that comes from thermal power plants. It has a pozzolanic quality. For 2 hours, samples are kept at high temperatures. At room temperature, F15 concrete has the most compressive strength of any other type. F15 concrete has the most compressive strength at all the higher temperatures that were aimed for. At room temperature, the UPV values of the cube samples of concrete were very high at all amounts of fly ash replacement. IS 13311 (Part 1): 1992 says that cubes of concrete that were heated to 200 oC were of good quality.

Sabarish et al. (2019) argued that promoting sustainable development should be the top priority for nations today. Fly ash is a product being produced in enormous quantities by thermal power plants, is significant. Scientific experiments were conducted to determine the precise extent toward which fly ash may substitute sand in mortar. Compressive and tensile strengths of cement mortar made with both pond types and bottom fly ash in varying percentages was evaluated. As an alternative to regular concrete, the use of fly ash as a cementitious ingredient was tried out. For both the M-25 and M-40 mixes, the cement has already been replaced with varying percentages of fly ash, from 0% (no fly ash) to10%, 20%, 30% and 40% (most of the cement). The findings of the tests for compressive strength up to 28 days and split strength for 56 days are used to make inferences about the mechanical characteristics.

Masuduzzaman et al. (2018) provided a synopsis of research into the potential uses of e-waste in concrete; results show that this waste has both positive and negative effects on the environment when added to aggregate. By incorporating various by-products into concrete, researchers may reduce our reliance on natural aggregates. And recycling old stuff is a lot more crucial.

Moen et al. (2021) The specimens were tested for tensile and compressive strength at 7, 14, 21, and 28 days after treatment using a variety of fly ashes in an effort to reduce waste and improve environmental conditions. Ash from coal, Vachellia nilotica (Kikar), and Dalbergia sisso (shisham) was substituted for cement at amounts between 10% and 50%. When used for 28 days, coal ash, Vachellia nilotica (kikar) ash, and Dalbergia sisso (shisham) all increase the tensile and compressive strengths of concrete and mortar by the same amount. A similar degree of improvement was seen in samples with healing fractions of 20, 30, 40, and 50%. Coal, Vachellia nilotica (Kikar), and Dalbergia sissoo (shisham) ash samples all lost strength and weight over time. Coal ash, when used in concrete at a concentration of 10% or more, can cut the price by 13.5 percent without compromising the concrete's strength. These materials are ideal for use in constructing lightweight structures, such as poultry and dairy buildings.

Liyanage et al. (2018) showed that fly ash may be used to replace some of the fine aggregate in concrete without compromising the strength of the finished product when subjected to various curing conditions. Up to 40% of the fine aggregate was swapped out for Class F fly ash. Two types of combinations, one containing simply cement and the other including cement and 15% fly ash, were tested. The research utilised accelerated heat curing for one day in addition to isothermal heat curing at temperatures of 300C, 500C, and 700C. Testing was done on compressive strength at 1, 3, 7, and 28 days. Compressive strength was greater in mixes that included fly as a partial fine aggregate replacement material compared to both the control mixture and mixtures that included and then curing it at a higher temperature, we get concrete with high compressive strength both at a young age and after it has had time to set.

Christy et al. (2010) The feasibility of using fly ash as a fine aggregate and cement substitute in mortar is being researched. Results for mortar mixes with cement replaced by several percentages of Class-F fly ash (0%, 10%, 20%, 25%, and 30% by weight of cement) in proportions of 1:3, 1:4.5, and 1:6 are shown. When cement is used to partially replace fly ash, the resulting mixture does have a higher compressive strength than one with a less dense mix. Experimental results show that a 1:6 ratio of fly ash to fine aggregate and cement in the cement mortar significantly improves the mortar's strength qualities. As long as the compressive strength of the brick unit is between and 3-20 N/mm^2.

Ibrahim (2021) find out what happens to regular concrete and glass fibre reinforced concrete when waste glass (WG) is used as a partial replacement for sand. At percentages of 0%, 10%, 20%, 30%, 40%, 50%, 60%, and 80%, WG was utilised to replace sand (fine aggregate) in concrete recipes. The cement weight in concrete mixes had 10% of it replaced with silica fume (SF), and 1% of that was replaced with ground flint (GF). Some hardened and fresh concrete qualities were assessed across a range of waste glass replacement percentages. As WG was used as a replacement for 20% of the cementitious material, the tensile and compressive strengths of the concrete were raised by around 12% and 15%, respectively, when compared to the reference mixes.

Patil et al. (2021) FA and SF's additive qualities to lessen the demand for cement. The mechanical properties of Composite-Fiber Reinforced High-Performance Concrete (CFRHPC), a material that blends glass and polypropylene fibers for reinforcement in concrete, have been proposed for research. The aggregate/binder ratio (A/B) was set at 1.75, while the water/binder ratios (W/B) were established at 0.275, 0.300, 0.325, and 0.350. For FA and SF, the volumetric replacement ratios were 0–15%, for GF, 0–1%, and for PPF, 0.25 percent was maintained.

Zaid et al. (2021) In a number of different mixes, coconut shell was used instead of coarse gravel. Five, ten, fifteen, and twenty percent of the Portland cement that was supposed to be in each batch of concrete was changed with silica fume. In this study, fibers were used in volume ratios of 0.5%, 1%, 1.5%, and 2%."Lab results and scanning electron micrographs from this study show that fibers could be added to coconut shell concrete to make it stronger and last longer. This would make it easy to make durable concrete that is strong enough.

Selvakumar et al. (2020) Instead of fine aggregate, glass powder is used, and basalt fiber is added to make the item stronger and last longer. To get the right strength in concrete, researchers are looking at how much glass powder is used instead of fine grit and how much basalt fibers are used. In tests done in a lab, using 10% glass powder instead of normal concrete made the material stronger and last longer. Achieved strengths include 84.5 MPa for compressive strength, 11 MPa for flexural strength, and 3.2 MPa for split tensile strength. Sorptivity and chloride penetrability, two ways to measure how long something lasts, were also better than the usual mix.

Prathyusha et al. (2020) examined a large variety of admixtures with the potential to lessen this problem while also enhancing concrete's properties. The use of environmentally beneficial supplementary integrants in concrete is further encouraged by the challenges emerging from increased pricing of constituents, dumping issues, and material scarcity. Current studies reveal the qualities of concrete made with Silica fume (SF) and glass fibre (GF), which are used in part as cement, and quarry waste, which is used in part as fine aggregate. Inflation caused by silica fumes leads to an increase in compressive strength. Meanwhile, a 10% silica fume/1% glass fibre blend is now considered optimal because to its superior tensile strength. Experiments are conducted by combining together waste marble dust (MD) and granite dust (GD) at varying percentages (from 0 to 30 percent) with an increase of 5 percent (by mass) of binder for both uncured and cure specimens, and conclusions are drawn by comparing the results to conventional concrete.

2.2 Properties of E-waste

E-waste, also known as electronic waste, refers to discarded electronic devices that are no longer functional or obsolete. E-waste can contain a variety of materials, including metals, plastics, glass, and other materials. The properties of e-waste can vary depending on the specific devices and materials involved, but here are some common properties:

Complexity: E-waste can be complex and diverse, consisting of a wide range of materials and components. This can make e-waste difficult to recycle and dispose of.

Toxicity:E-waste can contain dangerous things like lead, mercury, cadmium, and flame retardants that are made with bromine. If these materials are not handled properly, they can be harmful to people's health and the environment.

Resource value: E-waste can also contain valuable resources, such as gold, silver, copper, and rare earth metals. These materials can be recovered through recycling and reused in new products.

Quantity: Due to the expansion of the electronics sector and the frequently short lifespan of electronic equipment, the amount of e-waste being produced is rising quickly.

Environmental impact: Improper disposal of e-waste can have significant environmental impacts, including soil and water pollution, and the release of greenhouse gases.

It is important to manage e-waste properly to minimize its negative impacts and recover valuable resources. This can include recycling and reuse, as well as proper disposal methods to prevent the release of toxic materials into the environment. Many countries have regulations and programs in place to manage e-waste and promote responsible recycling and disposal practices.

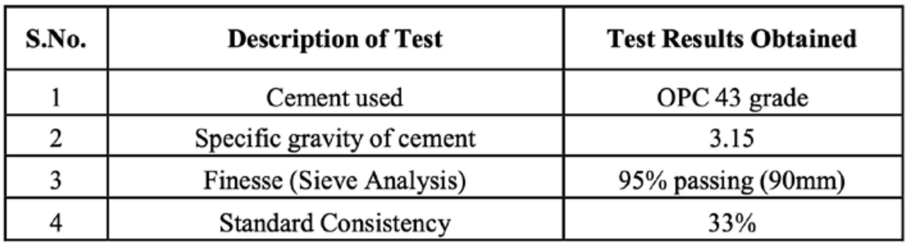
CHAPTER 3

RESEARCH METHODOLOGY

3.1 Materials

Cement (OPC 43 grade): Ordinary Portland cement of 43- Grade IS-8112: 1989 of BIS was the standard that was most often cited (Reaffirmed on 2005). Specific gravity of the cement utilised was 3.15, with a Soundness of 1 mm and a Normal Consistency of 33%.

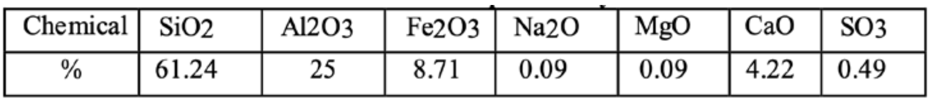
Table 3.1: Cement Properties



S.No.	Description of Test	Test Results Obtained
1	Cement used	OPC 43 grade
2	Specific gravity of cement	3.15
3	Finesse (Sieve Analysis)	95% passing (90mm)
4	Standard Consistency	33%

Fly ash: “In place of cement, low-calcium fly ash was used; this ash had "a whitish-grey color, a specific gravity of 2.16, a fineness of 327 m2/kg, and a moisture content of 0.15%.. Mandideep, a neighbourhood in Bhopal, where we'll collect the fly ash. Experimental activities involved sieving fly ash below to 90 microns to see how finely it may substitute cement.

Table 3.2: Chemical Properties of Fly Ash



Chemical	SiO_2	Al_2O_3	Fe_2O_3	Na_2O	MgO	CaO	SO_3
%	61.24	25	8.71	0.09	0.09	4.22	0.49

“Glass fibre: In this experiment, alkali-resistant glass fibers measuring 12 millimeters in length were used. These fibers had a tensile strength of 2.7 gigapascals, a specific gravity of 2.68, a modulus of elasticity of 80 gigapascals, an aspect ratio of 600, a filament diameter of 20 micrometers, a density of 3.99 mg/m3, a melting point of 650 degrees Celsius, and a moisture rate of 0.2. Additionally”.

Fine Aggregate: The fine aggregates used were readily available at a low cost from nearby suppliers. Particles that pass the 4.75mm IS sieve but retain a significant amount on the 75micron sieve are considered fine aggregate. Specific gravity of the fine aggregates employed was 2.57, and the fineness modulus was 2.51.

Coarse Aggregate: Coarse aggregate consisted of material that was able to pass through a 40mm sieve but still be maintained by a 4.75mm sieve. For this experiment, we used locally sourced natural aggregates produced from naturally eroded and deposited rock. 10mm and 20mm coarse aggregates were employed; their specific gravities were 2.72 and 2.64, and their fineness elastic modulus were 6.59.

3.2 Mix Proportions

Data

Grade –M25

Cement –OPC 43 grade conforming to [IS 8112]

Nominal size of aggregate =20mm

Maximum cement content =450kg/m3 [IS456:2000 cl. 8.2.4.2, page no.19]

Minimum cement content =300kg/m3 [IS456:2000 Table no.5, page no.20]

Compaction factor =0.9

Workability =75

Exposure condition =Moderate

Concrete having a typical strength of 25 N/mm^2 must be used to cast the sample. The following is an examination and presentation of the physical attributes of the component materials:

Fig. 3.1.: Proportion of water-cement ratio

Calculation of water content

- Maximum water content % for 20mm aggregate =186 liter (25mm to 50mm slump range) for 75mm slump =186+3%*186

  =191.58mm ≈192mm

Determination of cement content [IS 10262:2009 Table-2]

C = water/(water-cement ratio)

= 192/0.43 [water- cement ratio assumed=0.43]

= 446.51kg

450>446.51>300 kg/m^3 hence ok

Table 3.3: Mix design

S.N	Percentage	Cement kg/m^3	Fly ash kg/m^3	Coarse aggregate Kg/m^3	E-Waste Kg/m3	Fine aggregate kg/m^3	Water kg/m3
1	0	446.51	0	1035.23	0	727.27	0.43
2	10	401.86	44.65	931.71	103.52	727.27	0.43
3	20	357.21	89.30	828.18	207.05	727.27	0.43
4	30	312.56	133.95	724.65	310.58	727.27	0.43

3.3 Procedure

A mechanical concrete mixer is used for mixing. In order to prevent cement from adhering to the mixer's blades or the bottom of the drum, the mixer must first be wetted with regular Using water, a measured amount of Super Plasticizer, and a thorough stirring of the mixture.The next step is to place aggregate into the drum. A further 25% water and super plasticizer are added, and then sand is added. Cement and other admixtures, if any, are thoroughly mixed with the aggregates before e-waste is added. Super plasticizer and the remaining half of the water have been added.

A slump test is used to determine the workability of each mixture. There are 12 identical 100100100 mm cubes, 3 identical 100100200 mm cylinders, and 3 identical 100100500 mm beams made from each proportion. The total number of cast objects is 168 cubes, 42 beams, and 42 cylinders. After the molds are filled with concrete, they are crushed using a vibration table. After casting for 24 hours, remoulding was completed. In a curing tank, specimens are dry out. The method of cure by immersion in water is used. In the compressive testing and flexural testing equipment, cubes, cylinders, and beams of any proportion are cast and tested for compressive, tensile, and flexural strength.

3.4 Experimental Plan

The experimental program was created with M25 grade of regular concrete in mind for the mechanical qualities of concrete, such as compressive strength and flexural strength. A total of 30 cubes and 30 beams, each measuring 150 mm by 150 mm by 150 mm and 500 mm by 500 mm by 700 mm, were cast as part of the programme and tested. Fly ash and glass fibre were used in the casting process. All specimens were examination using a compression testing machine (CTM).

3.4.1Mixing

The concrete mixture was made on the waterproof platform by hand mixing. In the dry stage, the cement, fly ash, and E-waste were properly combined before the sand was added. The mixture was once more well combined before being spread over the coarse aggregate. When mixing fibre reinforced concrete, steel fibres were dispersed uniformly. Following that, water was gradually added while mixing chemical admixture. Up till a usable combination was achieved, mixing was done.

3.4.2 Casting

The concrete molds were layered three times with fillers The concrete blocks will indeed be compressed 25 times in each layer. The table vibrator was utilized to give the cube moulds a vibrational shake. To ensure even compaction, the vibrations lasted for a full minute. After 24 hours, the specimen were demolded and cured for 7 to 28 days in a curing tank.

3.4.3 Curing process

Curing is a method in which a concrete specimen or concrete building is submerged in water for a certain period of time (the number of days varies depending on the specimen). For instance, the compressive strength of a paver block is measured after it has cured for 15-21 days.

Fig. 3.2: Curing of cubes, beams and cylinders

3.4.4 Test conducted

Universal Testing Machine (UTM) used for testing various concrete combinations The flexural and compressive strengths were determined by tests. Each sample of concrete is subjected to a standardised set of tests, and the mixture's performance is analysed.

Compressive strength test

“In order to determine the compressive strength of concrete of the M25 grade, cube specimens of 150 millimeters on a side, 150 millimeters on a face, and 150 millimeters in height were used. In accordance with IS 516-1959, concretes of grade M25 were subjected to compression tests to determine their compressive strength. The compressive strength of concrete made using portland cement, electronic waste, and fly ash is evaluated seven, twenty-one, and thirty-eight days after placement”.

Fig. 3.3: Specimen loading for compressive strength test

Maximum compressive load per unit area is employed to determine compressive strength. As a result, the failure load was recorded. Cubes were evaluated for their worth in each area. This is how we determined the compressive strength,

Compressive strength (MPa) = Failure load / cross sectional area.

Flexural strength test

According to I.S.516-1959, beam specimens with an effective span of 600 mm were evaluated for flexural strength using a two-point loading setup. The flexural loads at failure were used to calculate the average ultimate flexural tensile stress. Specimen beams of 150 mm by 150 mm by 700 mm were used to gauge flexural strength. The quality of the beam samples was checked after 28 days. By gradually raising the load until the beam specimen splits, the failure load is ascertained. The flexural strength test was discovered on day 28. We were able to determine the flexural strength as using this data.

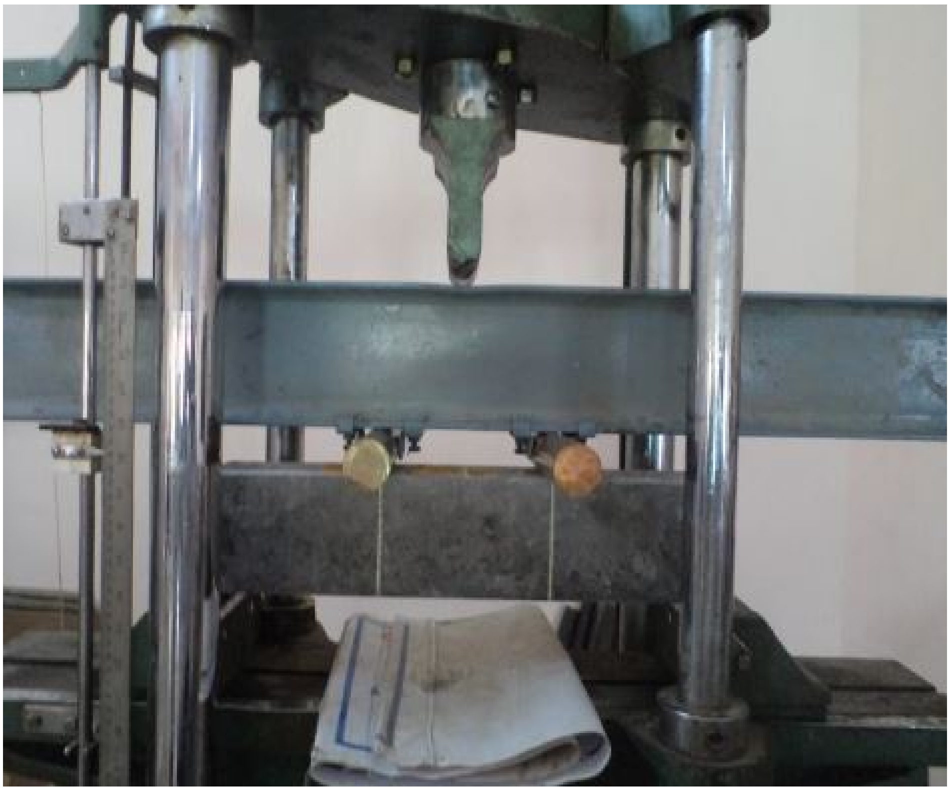


Fig. 3.4: Specimen loading for flexural strength test

Split tensile strength test

The test is performed in a compression-testing machine with a capacity of 200 tonnes by inserting a cylindrical specimen of concrete with its axis parallel to the plates of the machine. The Fig.3.5 image depicts the experimental setup for the Split tension test. The force was applied continuously and evenly until the object broke along its y axis. The tensile stress at the point of fracture is determined using an equation based on those given in International Standard (IS) 5816-1970.

The concrete's split tensile strength may be calculated using the following relation.

Fig. 3.5: Specimen loading for split tensile strength test

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Mechanical Properties

Mechanical properties compressive and flexural tests, among others, are used to evaluate resilience..

4.1.1 Workability

Slump test was done to determine the workability of the nominal mixed concrete and the control mixes (Fly ash and E-waste mixed concrete).

Table 4.1: Slump Cone Test Values for Fly ash and E-waste mix Concrete

% of Fly ash and E-waste mix	Slump (mm)
0	78
3	71
6	69
9	63

4.1.2 Compressive Strength Test

Total 18 cubes were made by pouring concrete that had been combined with either 10%, 20%, or 30% fly ash and electronic trash as a substitute. In addition, six cubes were cast from regular cement concrete. Both 7 and 28 days of curing were successful for all the samples. In this research, we find that adding 20% Fly ash and 20% E-waste to concrete somewhat increases its average compressive strength.

“Because strength is directly tied to the structure of the hydrated cement paste, a test of the concrete's compressive strength often provides a comprehensive picture of the material's quality. Cube specimens was tested for compressive strength at 7, 14, and 28 days of age”.

Table 4.2: 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

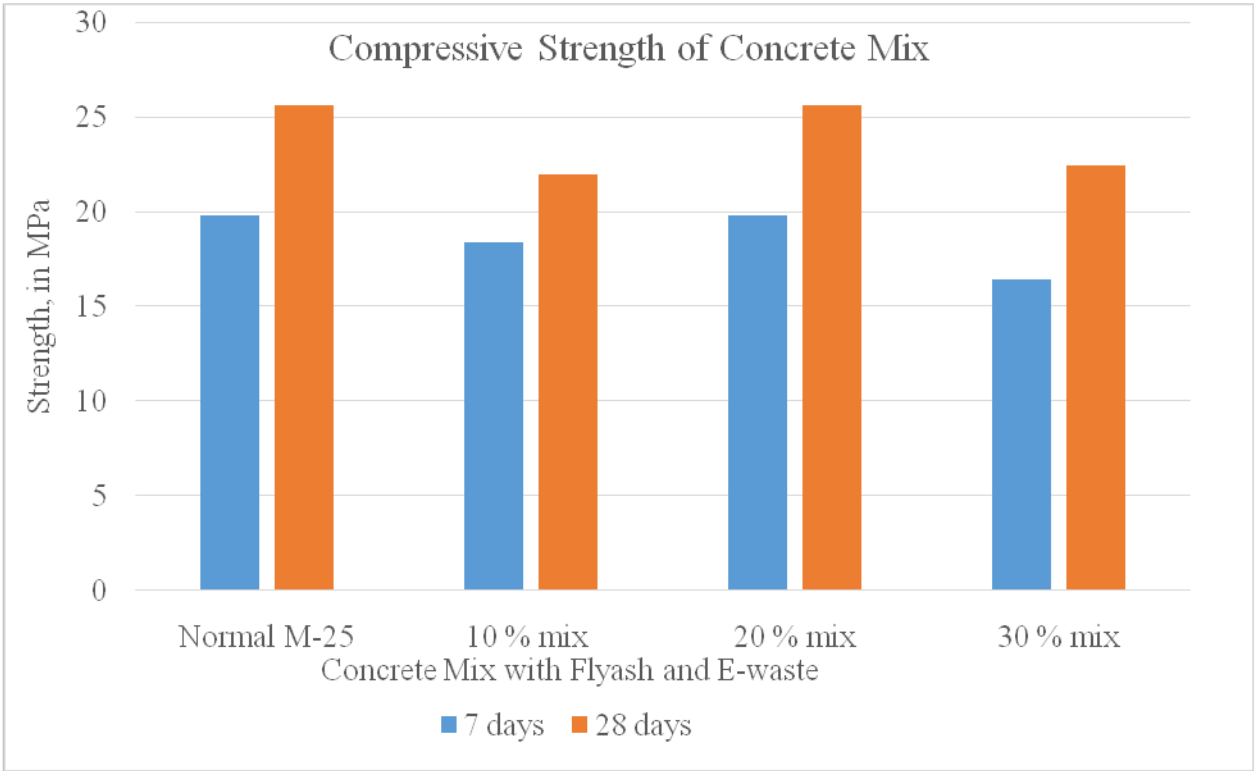


Fig. 4.1 Compressive Strength

"The findings for cube compressive strength at 7 and 28 days are displayed in Table 4.1. These findings are for a variety of replacement levels, including 10%, 20%, and 30% of cement with fly ash and E-waste to the weight of concrete. At a mix concentration of 20%, the maximum compressive strength was measured at 25.63 N/mm2".

4.1.3 Flexural Strength Test Result

Glass powder was used to make a total of 6 beams at varied percentages (10%, 20%, and 30%). Additionally, 2 beams are made in ordinary cement concrete. The curing times for each specimen varied between 7 and 28 days. 20% of the study's average flexural strength Concrete made with more fly ash and e-waste is used.

Table 4.3: 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

“Table 4.3 shows the findings for flexural strength at 7 and 28 days for various replacement levels, such as 10%, 20%, and 30% of cement with fly ash and E-waste to the weight of concrete. At 20% mix, the maximum flexural strength was measured to be 4.15 MPa”.

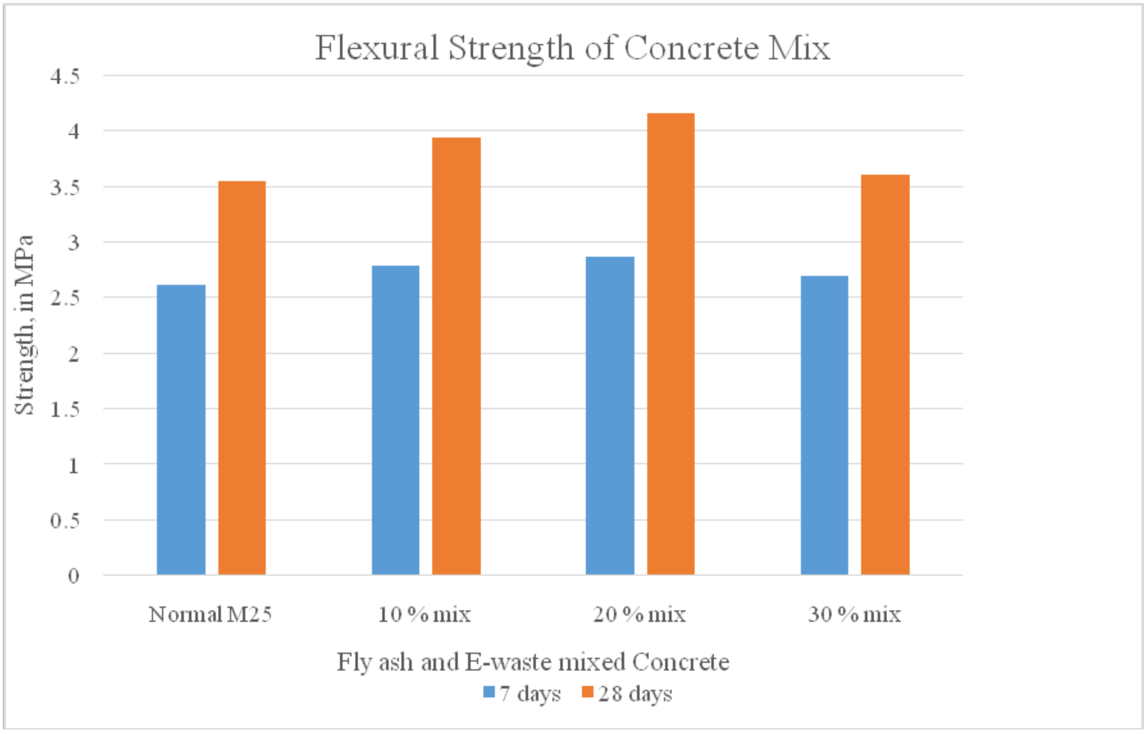


Fig. 4.2: Flexural Strength

4.1.4 Split tensile strength test result

Table 4.4: 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

“Total 6 cylinders, were casted by mixing Fly ash and E-waste of different percentage (10%, 20% and 30%). 2 cylinders were also casted with plain cement concrete. All the specimens were cured at different curing intervals 7 and 28 days. In present study average split tensile strength of 20% fly ash and E-waste mixed concrete is increased”.

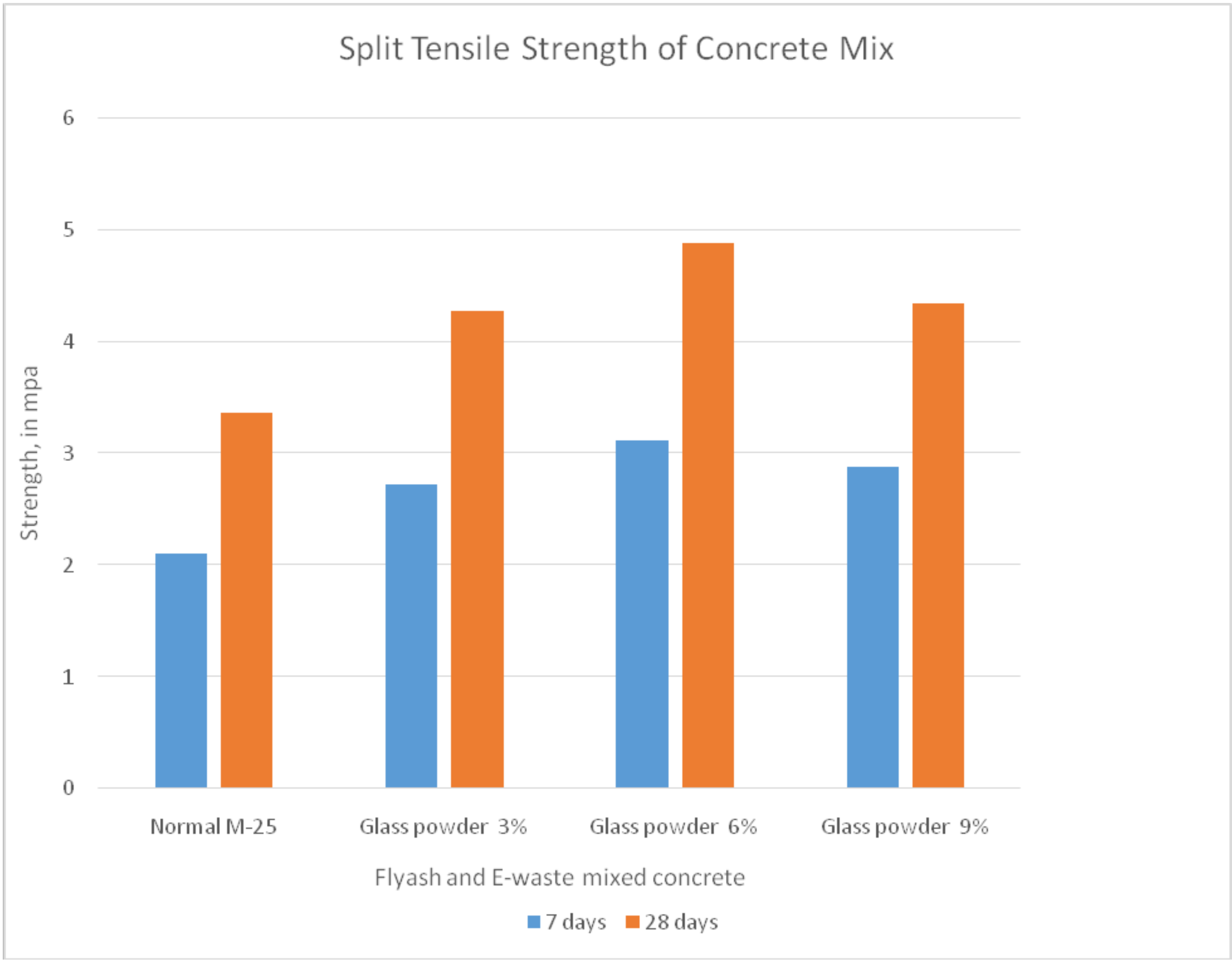


Fig. 4.3: Split tensile Strength

“The results of the split tensile strength test at 7 and 28 days for various replacement levels of cement with fly ash and electronic waste to the weight of concrete are reported in Table 4.4. These replacement levels include 10%, 20%, and 30% of cement respectively.At a concentration of 20%, the maximum split tensile strength was measured at 4.88 MPa”.

CHAPTER 5

CONCLUSION AND FUTURE SCOPE

5.1 CONCLUSION

Geopolymer concrete is a type of concrete that is made using fly ash, an industrial waste byproduct. Fly ash is a type of coal combustion residue that is produced when coal is burned in power plants. Geopolymer concrete is an alternative to traditional Portland cement-based concrete and is considered to be more environmentally friendly because it uses less energy and produces less CO2 emissions during its manufacturing process.

Researchers have been looking into using plastic and e-waste to replace some of the aggregates in concrete for the past few years. This method could reduce the damage that making concrete does to the environment and help solve the growing problem of plastic and electronic waste pollution.

Studies have shown that using a geopolymer made from fly ash in concrete can make it stronger and last longer than traditional Portland cement-based concrete. The amount of fly ash used in geopolymer concrete depends on how it is being used and what the project needs.

Plastic and e-waste can be mixed into concrete to improve its mechanical properties, such as its compressive and bending strengths. Using plastic and e-waste in concrete can also cut down on the amount of trash that ends up in landfills and lessen the damage that making concrete does to the environment.

But there are some things you can't do when you use plastic and e-waste in concrete. For example, there are limits to how much plastic and e-waste can be used in concrete. The type and amount of plastic and e-waste used can affect how well the concrete works.

In conclusion, the incorporation of fly ash-based geopolymer as well as plastic and electronic waste into concrete has the potential to lessen the negative effects that the manufacturing of concrete has on the surrounding environment and to offer solutions for the management of trash. Nevertheless, additional study is required in order to maximize the application of these materials in concrete and overcome any potential performance constraints.

In place of some of the cement and CA, fly ash and E-waste were added to the concrete to make it stronger and work better. The strength and durability of concrete can also be improved by adding fly ash

5.2 FUTURE SCOPE

There are several areas where future research could be focused to further explore the use of fly ash-based geopolymer and plastic and e-waste in concrete.

Fly ash dosage optimization in geopolymer concrete is one potential topic of study. More research should look at the usage of different fly ash sources and dosages to discover the most beneficial combination for specific applications, as different types and sources of fly ash can have varying effects on the characteristics of geopolymer concrete.

Finding ways to improve the plastics and electronic trash that can be used in concrete is another potential topic of study. Further study might look at using various forms of plastic and e-waste to discover the most effective combination for specific applications, as the mechanical qualities of the resulting concrete can be altered by the type and amount of plastic and e-waste utilized.

Additionally, future research could focus on the long-term durability and sustainability of concrete made with fly ash-based geopolymer and plastic and e-waste. Studies could investigate the effects of exposure to different environmental conditions on the mechanical and chemical properties of the resulting concrete to ensure its long-term durability and sustainability.

Finally, future research could explore the potential for scaling up the use of fly ash-based geopolymer and plastic and e-waste in concrete production. The use of these materials has the potential to significantly reduce the environmental impact of concrete production, so further studies could investigate the potential for widespread adoption of these materials in the concrete industry.

Research into alternative cementitious materials, such as industrial waste products and other natural minerals, has increased dramatically in recent years. Adding MK or SF to portlandite has been shown to greatly improve both the initial and ultimate strengths of the mixture, as shown in the reviewed research. As a result of their pore-filling effects, SF and MK both contribute to reduced pore structures in cement paste. MK and SF are both more cost-effective and eco-friendly than OPC. More individuals will use MK and SF in concrete as they learn about its benefits, leading to cheaper prices and less negative impacts on the environment from the cement industry.

1. It is possible to assess the strength of concrete integrating various Metakaolin and Silica fume replacement ratios.

2. Using a different water cement ratio and substituting coarse aggregate and fly ash for cement

3. It is possible to assess the strength of concrete that contains various mineral admixtures.

4. It is possible to determine the strength of concrete with various types of fibres.

5.3 Recommendation

Based on the current state of research on the use of fly ash-based geopolymer and plastic and e-waste in concrete, there are several recommendations that could be made for practical applications:

Conduct a thorough feasibility study: It's vital to undertake a feasibility analysis before deciding to use fly ash-based geopolymer and plastic and e-waste in concrete. Material availability and cost, ideal fly ash and plastic and e-waste dose, and environmental impact assessments are all factors to consider.

Optimize the mix design: Mechanical qualities of concrete constructed from fly ash-based geopolymer, plastic, and e-waste might vary depending on the type and amount of materials utilized. To ensure the concrete's performance matches the required criteria, it is crucial that the mix design be accurate.

Ensure proper testing and quality control: To ensure the durability and long-term performance of concrete made with fly ash-based geopolymer and plastic and e-waste, it is important to conduct proper testing and quality control during the manufacturing process. This can include testing the compressive strength, flexural strength, and durability of the concrete, as well as ensuring that the mix proportions are accurate and consistent.

Consider the environmental benefits: The use of fly ash-based geopolymer and plastic and e-waste in concrete can provide significant environmental benefits, including reduced carbon emissions and waste reduction. When evaluating the use of these materials, it is important to consider the potential environmental benefits as well as the performance and cost considerations.

Collaborate with experts: It is important to collaborate with experts in this field to ensure that the project is designed and implemented correctly and to avoid potential performance issues or safety concerns.

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