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| **FLY ASH GEOPOLYMER** |

**Abstract**

At present day, demand of concrete has grown at an exponential rate. It is estimated that concrete is the second most used resource preceded by water. Traditionally, in order o manufacture concrete Ordinary Portland Cement was used. However, this process of using OPC to make concrete used to release a huge amount of carbon dioxide in the surrounding environment. Hence, manufactures were keen to come up with an environment friendly alternative to produce concrete. As a result, Fly ash based Geopolymer concrete is used. The primary aim of this paper is to produce detailed facts regarding the Fly Ash Geopolymer and discuss its various contributions in the process of making concrete.

**Table of Content**

Table of Contents

1.Introduction: 4

2. Fly Ash Geopolymer: Related work 4

3. Problem Statement- 5

3.1 Sub Problem 5

3.2 Hypothesis 5

3.3 Delimitation 5

3.4 Assumption 5

3.5 Definitation of term 5

4.Application of Geo Polymer: 6

5.Importance of GeoPolymer: 7

6.Methodology 8

6.1 Organization of sample 8

6.2 Details of specimen 8

6.3 Experiment process 9

6.4 Results 9

7.Conclusion: 10

Reference List: 11

# 1.Introduction:

Geopolymer is nothing more than an alkali binder, which is formed by activations of alkali silicate of various aluminosilicate materials. It was first invented in the year of 1978. The cement industry is one of the largest payer of Central Excise and one of the largest contributors to global GDP. It is important to note that, as the global infrastructure is on the boom since last decade, the demand of cement industry is very high. One of the most important products of the industry is concrete. However, it is important to know that, cement industry in general consumes a huge amount of energy in order to manufacture their products mainly concrete. It is estimated that right after steel manufacturing of concrete and Portland cement is one of the largest consumer of fuels (Castel *et al.* 2015, p.50).

# 2. Fly Ash Geopolymer: Related work

It is estimated that, in order to manufacture concrete, more than 4GJ per of energy is required to produce only one ton of the product. One of the most widely used fuel to run this industry is coal. There are as per estimation more than 5000 mini cement plants located all over the globe. Thus, this data is alone to prove the amount of fuel is consumed each year by this industry. It is known fact that these fossil fuels are not unlimited and in fact, the world deposit of coal is getting depleted at an alarming rate each year. Along with this, as discussed before, the entire process releases tons of CO2 each year, damaging the surrounding environment to a huge extent. Along with this, it also believed one of the largest contributors global warming (Nath *et al*. 2014, p.170).

The global cement industry have now turned their attention towards using Fly Ash geopolymer in order to make sure all such problems are being mitigated to a large extent. The Fly Ash Geopolymer cement concretes contain inorganic composites. These inorganic composites are assumed to be prospective concretes which have the potential to become a substantial environment friendly element which can be used both to manufacture and replace traditional concretes. It is important to note that the new substance has have even a higher strength and better resistance to acid attacks and other factors which might damage the overall quality of traditional concrete. Unlike traditional concrete and other products of cement industry, the geoploymer does not tend to form CSHs better know n as calcium silicate hydrates in order to forma matrix for strength. Rather the geopolymer utilizes the polyccondensation of silica and alumina to gain strength for its structure. There are two main constitutes of the geoploymer: first is the very source materials and second is the alkaline liquids. In order to produce the by material of the geo polymer which is the fly ash, the source materials needs to have both silicon and aluminum. The fly ash geo polymer has unique when compared to aluminiosilicate materials. The basic properties of geo polymer concrete are as follows:

* The drying shrinkage in geo polymer when compared to traditional cement is much lower. This makes it even more durable than that of traditional concretes. Hence, it can provide a better reinforcement to all the concrete structured members.
* The traditional concrete has a much higher hydration due to heat. Hence, manufacturing building which is often placed near to heating environment makes them very fragile and as a result, the infrastructure can collapse. However, in geo polymer concretes, this problem can be reduced to a good extent.
* Geo polymer concrete offers a better reinforcement as to traditional concretes. It is due to fact geo polymers chloride rating is very low (Khan *et al*. 2016, p.222).
* Geo polymer concrete also offers a very high acid resistance when it is exposed to sulphuric acids roughly concentrated to 2-10%.

# 3. Problem Statement-

Geo polymer has been used extensively since last few years due to its credibility to replace traditional concrete. Along with this, there has been a vast development in the process of developing geosynthesis fly ash applications. New and more top notch materials have been designed in order to create new applications and procedures in order to transform new ideas which have been implemented to grant in both inorganic as well as in mineral chemistry. Hence, the problem statement is to critically evaluate the application of Geo Polymer along with the design process of Geo Polymer concrete.

## 3.1 Sub Problem

To analyse the strength of fly ash based geopolymer

To compare it with other mixes

## 3.2 Hypothesis

Compressive strength of fly ash based geopolymer is greater than other mix of geopolymer

## 3.3 Delimitation

 Only water based geopolymer will be compared with fly ash based geopolymer

## 3.4 Assumption

Normal density with unit weight of 2400kg/m3

Mass of combination of aggregates=77% of Geopolymer= 1848kg/m3

## 3.5 Definitation of term

Geopolymer- Its binding system which become hard at room temperature

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# 4.Application of Geo Polymer:

A number of modern infrastructure have been made up geo polymer concrete and number foundations have been build which are stronger and is more resistant towards external corruptions. Along with this, the new infrastructures which are made by geopolymer concrete ia far stronger when compared to traditional concrete (Phoo-Ngernkham *et al*. 2018, p.22).

As stated before, the entire process of manufacturing concrete and cements consumes a huge amount of fossil fuels which is considered to be one of the prime contributors of global warming. It is estimated around more than 7% of total global warming is contributed by this process alone. However, manufacturing geo polymer cements this problem can be reduced to more than 70% less emission of CO2. As per a recent European project which was mainly based up on Fly Ash-based geo polymer cements, they are going to replace the traditional cement manufacturing process in upcoming decade. One of the biggest applications of rock based geopolymer cements is that they are most suitable for manufacturing infrastructure in order to contain various activities such as hazardous waste and other toxic materials. In fact, most of the nuclear power stations constructed today is mostly made up of similar cements. This is because, unlike in traditional cements, the hydration due to heat is much higher in geo polymer cements. Hence, this reduces the chance of any fatal consequence in such infrastructures.

The rock base geo polymer cements and Fly Ash is perhaps better applications of all other forms of the respective cement. The overall tensile strength of infrastructures made with such materials is very high. One of the best applications of geo polymer cement is that, the structural strength can be controlled and in fact, the overall maintenance cost of infrastructures made with such material are generally lower than that of traditional cements. Another major application of geo polymer cement is that they are widely used in manufacturing the runaways for many heavy load carrying aircrafts. It is interesting to note that, even a freshly build runway can withstand the Boeing or even Airbus plane. The only condition is that the runway can be used after four hours it has been made. Such is the durability of geopolymer cement.

In order to understand the actual reason for geopolymer cements to be this effective over traditional cements is its composition. The compositions are follows:

* **First**: Fly Ash Geo polymers are extremely easy to manufacture. The overall capital and energy invested in it are considerably low and the heat required to manufacture it is also low.
* **Second**: traditional cements have are made up organic compositions which have a lower heat tolerance. Geo polymer on the other has proven that it does not burn at all. Thus, having a higher heat tolerance.
* **Third:** it is interesting to note that, the mechanical properties of the Fly Ash geo polymer cement is mostly similar to traditional cements. Along with this, geopolymers have a higher resistance to almost every organic solvent (Yao *et al.* 2015, p.120).

# 5.Importance of GeoPolymer:

Fly Ash Geo polymer cement has completely altered the concept of concrete. Today, they are widely used to build many major highways and important major infrastructures all around the world. Some of the major advantages of geo polymer concrete are as follows:

* **High tensile strength**: the overall compressive strength in geo polymer is way higher than that of ordinary concrete. One of the biggest advantages of the geo polymer is that it has a higher pace to gain overall structural strength and the overall duration to gain its maximum strength is also lower when it is compared to ordinary cement. It has also a faster tendency to get cured and hence makes it a better alternative to build new roads on emergency situations. As the geo polymer cement has a higher tensile strength than that of traditional cements, it is less brittle as well. Hence. It can tolerate sudden and unpredicted movements. It is important to note that it is not immune to earthquake however, it can sustain higher damage (Nath *et al*. 2017, p.30)
* **Lower shrinkage:** shrinkage is one of the most common problems in ordinary cements. This shrinkage can result to dangerous cracks which make the entire infrastructure extremely dangerous to use for prolonged duration and might lead to collapse. One of the most contributing factors which results to crack is extreme heating of concrete and also evaporation of water. One of the biggest advantages of replacing ordinary cement with geo polymer cement is that it does not gets hydrated very easily hence, the chances of observing a shrinkage in such infrastructures is very low, making the building or the roads stable. Even the creep in geopolymer is extremely low. The term creep with the context of concrete is defined as the situation when the concrete gets deformed beyond repair when constant force is applied against it for a considerable amount of time.
* **Better resistant to temperature change:** Geo polymer has an incredible ability to remain stable in extreme temperatures. According to many experts, geo polymer concrete has proven to remain functional at a staggering 2200 degrees Fahrenheit. It is known fact that, extreme weather conditions have a dramatic effect on ordinary concretes; hence, using geopolymers can help to avoid the problem to a great extent (Law *et al*. 2015, p.730).

Geopolymers is not entirely free form flaws. Although, it can be termed as to be super concrete, there are some major drawbacks which make the credibility of suing such cements at stake. Some of the most notable ones are described below:

* **Difficulty in manufacturing**: although, while manufacturing such super concretes produce less environmental pollution and has a number of benefits over traditional cements, the entire process of actually manufacturing it is somewhat complex in nature. It is due to this factor, many of the smaller plants restrain themselves form making it as they do not have the expertise to manufacture it. Along with this, it is important to note that, the chemical used for making this super concrete are harmful to the humans if handled without proper instructions.
* **Extremely sensitive:** the entire process of geoplymerization is extremely sensitive in nature. This super cement lacks uniformity and is extremely volatile in nature. Hence, handling this type of concrete require high expertise.
* **Pre-Mix**: one of the biggest problems of geopolymer concrete is that it is only sold as pre-mix version only. It is usually done in order to avoid all the dangers of being used without any caution and for the fatal consequences of it (Sarker *et al*. 2014, p.590).

# 6.Methodology

Experimental design is used for this research. The previous literute is used for the explanation of topic. Secondary data is also used alongwith experimental data to conduct this research. The selected research design is exploratory as it explore the situation. Google scholar and educational library is used to search relevant articles. Geopolymer, fly ash, application of Geo Polymer key words are used to search articles.

## 6.1 Organization of sample

**Experiment design-** In this experiment, influence and role of fly ash based geoploymer is evaluated. Hardened and fresh Geopoymer is chosen as the performanace critiera. The parameters are alkaline liquid fly ash ratio, water geopolymer ratio, wet mixing time, heat curing time and heat curing temperature.

## 6.2 Details of specimen

Liquid fly based polymer 0.30-0.45 ranges are selected. Below mention data is recomneded for fly ash based geo polymer.



## 6.3 Experiment process

Following process will be followed

Requirement- Low calcium fly ash based geo polymer

Compressive strength 45Mpa

## 6.4 Results

Trail Mixture proportion is below mentioned

Combined aggregates- 1848kg/m3

Fly Ash-408kg/m3

Sodium Silicate-103kg/m3

Sodium Hydroxide-41kg/m3

**Water to Geopolymer**

Water-58kg

Solid-45kg

In this experiment, numerous batches of different ration has been produced and compressive strength is calculated.

# 7.Conclusion:

In order to finally conclude it needs to be stated that, the Fly Ash Geopolymer is no doubt the best alternatives of traditional cements in order to create better infrastructure. It has a huge opportunity in future and can ultimately replace traditional cements. It is both effective in terms of consumption of energy and capital required to manufacture it and covers all the drawbacks of traditional cements to a broader extent. The only problem with it is that it is not used widely as per traditional cements and hence, many of the plants does not have all the skills to manufacture it. It is only with due time, these drawbacks can be mitigated to use the geopolymer cement to its full potential.