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## A Review on the Durability Properties of Geopolymer Concrete with the Combination of GGBS and FlyAsh

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**ABSTRACT:**In the field of construction the manufacturing of Portland cement will affects the emission of pollutants which leads to environmental pollution. We can decrease the pollution effect on environment, by increasing the consumption of industrial by-products in our construction field. In this study to produce the concrete the OPC is fully replaced with GGBS fly ash and alkaline solutions are used as a binding material. The alkaline solutions used in this study for polymerization such as sodium hydroxide and sodium silicate. The specimens were made of required size. Through that specimen compressive strength test, split tensile strength and flexural strength test were determined by curing the specimens were kept at 65°C after that the durability properties of geo-polymer concrete were examined

**KEYWORDS:**GGBS, Fly ash, Durability properties,geopolymer concrete.

### I. INTRODUCTION

Geopolymer concrete is considered to be an innovative material that is a viable alternative to traditional Portland concrete or cement used in transportation infrastructures, certain constructions and offshore builds. It is very resistant to several of the durability issues that can cause traditional concretes to crack and crumble. This is accomplished by using minimally processed natural materials or industrial by-products. Geopolymer concretes will cure more quickly than Portland concretes. They have obtained most of their strength within 24 hours. This type of concrete is starting to revolutionize concrete. It is being used more and more in highway construction projects and offshore applications. It is still a little too pricey for the do-it-yourself projects that abound, but contractors are starting to use it more and more in other construction projects. It is a newer product that is making traditional concrete look not so spectacular. Here are some of the top advantages of geopolymer concrete. It has a high compressive strength that showed higher compressive strength than that of ordinary concrete. It also has rapid strength gain and cures very quickly, making it an excellent option for quick builds. Geopolymer concrete has high tensile strength. It is less brittle than Portland concrete and can withstand more movement. It is not completely earthquake proof, but does withstand the earth moving better than traditional concrete. Shrinkage can cause severe and even dangerous cracks in the concrete from the drying and heating of the concrete or even the evaporation of water from the concrete. Geopolymer concrete does not hydrate it is not as permeable and will not experience significant high shrinkage. The creep of geopolymer concrete is very low. When speaking of creep in concrete terms it means the tendency of the concrete to become a permanently deformed due to constant forces being applied against it. It has the ability to stay stable even at temperatures of more than 2200 degrees Fahrenheit. Excessive heat can reduce the stability of concrete causing it to spall or have layers break off. Geopolymer concrete does not experience spalling unless it reaches over 2200 degrees Fahrenheit. As for cold temperatures it is resistant to freezing. The pores are very small but water can still enter cured concrete. When temperatures dip to below freezing that water freezes and then expands this will cause cracks to form. Geopolymer concrete will not freeze. It has

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a very strong chemical resistance. Acids, toxic waste and salt water will not have an effect on geopolymer concrete. Corrosion is not likely to occur with this concrete as it is with traditional Portland concrete.

## II. ABOUT DURABILITY PROPERTIES

### Durability of concrete

Durability of concrete can be vaguely defined as the longevity of the material against various environmental conditions. Concrete is considered equivalent to a rock. We know it's pretty durable in a sense that ordinary water or atmosphere does not affect it - these agents could intrude into the concrete matrix but do not cause any deleterious effects. Durable life is considered as the time before the material shows signs of distress. For example, plain concrete is unaffected by processes like carbonation where as corrosion from carbonation affects RC structures. Some of the most common distresses observed are AAR (Alkali aggregate reactions), Corrosion (RC structures only), Sulphate attack, Freeze - thaw attack, shrinkage (a combination of environment - material characteristic) etc. Durability of concrete may be defined as the ability of concrete to resist weathering action, chemical attack, and abrasion while maintaining its desired engineering properties. Construction industry needs faster development of strength in concrete so that the projects can be completed in time or before time. This demand is catered by high early strength cement, use of very low W/C ratio through the use of increased and reduced water content. This results in higher thermal shrinkage, drying shrinkage, modulus of elasticity and lower creep coefficients. As the creep coefficient is low in such concrete, there will not be much scope for relaxation of stresses. Therefore, high early strength concretes are more prone to cracking than moderate or low strength concrete. The structural cracks in high strength concrete can be controlled by use of sufficient steel reinforcements. But this does not help in concrete durability, as provision of more steel reinforcement, will only result in conversion of the bigger cracks into smaller cracks. Even these smaller cracks are sufficient to allow oxygen, CO<sub>2</sub>, and moisture get into the concrete to affect the long term durability of concrete.

### Factors affecting durability of concrete

Concrete or plastic concrete is a freshly mixed material which can be moulded into any shape. The relative quantities of cement, aggregates and water mixed together, control the properties of concrete in wet state as well as in hardened state. For a long time, concrete was considered to be very durable material requiring a little or no maintenance. The assumption is largely true except when it is subjected to highly aggressive environments. Concrete structures are built in highly polluted urban and industrial areas, aggressive marine environments, coastal areas and many other hostile conditions. Since the use of concrete in recent years, have spread to highly harsh and hostile conditions, the earlier impression that concrete is a very durable material is being threatened, particularly on account of premature failures of number of structures in recent past. Durable concrete will retain its original form, quality, and serviceability when exposed to environment.

a) **ENVIRONMENT:** Environment can be classified as 2 types:

#### 1. PHYSICS:

**Temperature:** Temperature affects the rate of hydration. Unfavourable temperature conditions can lead to shrinkage cracks and volume changes. Variation in temperature changes cause secondary stresses in structures.  
**Moisture:** Moisture induces corrosion in steel. Moisture also acts as a carrier of chemicals inside the body of concrete. Moisture can also cause efflorescence on structural surfaces. Seepage / Leakages cause inconvenience to occupants and deteriorates structures due to permeable concrete. Freezing and Thawing leads to expansion of concrete and cracking. Ice-melting salts cause erosion of concrete.

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## 2.CHEMICAL:

When we are dealing with durability, chemical attack which results in volume change, cracking and consequent deterioration of concrete become a major cause of concern.

### Types of Chemical attack

- Sulphate attack
- Alkali aggregate reaction
- Chloride ion attack - Corrosion
- Carbonation
- Acid Attack
- Effect on concrete in Seawater

### b) WORKMANSHIP:

Batching, Mixing, Transportation, Placing, Compaction and Curing require proper workmanship for a durable concrete.

### c) COVER TO EMBEDDED STEEL: (AS PER IS 456:2000)

1. For main reinforcement up to 12 mm dia bar for mild exposures, the nominal cover may be reduced by 5 mm
2. Unless specified otherwise, actual concrete cover should not deviate from the required nominal cover by +10mm or 0mm.

### • Mineral Oil :

Usually effects only fresh concrete in their hardening process (petrol, petroleum distillates etc).

### • Organic Acid: It has corrosive effect

### • Vegetable & Animal oils & Fats

It causes deterioration of concrete surfaces due to their corrosive action.

### • Action of Sugar

It has retarding effect on fresh concrete; has gradual corrosive effect on hardened concrete.

### • Action of Sewage

It concrete sewers running full remain unaffected; but in partially filled sewers where hydrogen sulphide gas is evolved & sulphuric acid is formed, concrete above sewage level gets affected due to corrosive action of such acids. In the recent revision of IS 456:2000, one of the major points discussed and revised is the durability aspects of concrete, in line with codes of practices of other countries who have better experiences in dealing with durability of concrete structures. Strength and durability are the 2 important properties of concrete. They are like two legs of human body. In India with the availability of good cement since 1985, good strength can be obtained if reasonable care is taken. But, same thing cannot be said about the durability, because the rapid deterioration in environmental conditions and the use of concrete has spread to much more hostile regions. Concrete is a very loyal and dependable construction material. It should not be abused to the limit as it is done today.

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### III. AUTHORS REVIEW ABOUT DURABILITY OF GEOPOLYMER CONCRETE

In this paper Ankur Mehta (150) 2017 investigated that he replaced flyash as partially with 0,10,20 and 30% of OPC the test were conducted for permeation properties such as water absorption, porosity, sorptivity and RCP test up to one year. The addition of OPC showed in the decreases in water absorption, porosity, sorptivity and RCP test of GPC because of the enhancement in microstructure. The output of this experiment were also confirmed by the microstructural analysis, SEM, EDS and XRD which concludes good compacted and dense microstructure of GPC with the inclusion of OPC. Addition of OPC after 20% gradually decreased the permeation properties by the formation of lesser geopolymeric binders more than the hydrated calcium based binders[1].

In this experimental study Lateef Assi (123) 2016, he presented the effect of sodium hydroxide ratio, external heat amount and partial replacement of OPC on fly ash based GPC were determined. The water absorption and voids ratio were measured and microstructure of fly ash based geo-polymer paste was characterized. The combination of silica fume, sodium hydroxide, and water were used as the activator solution. Here he had used scanning electron microscopy (SEM) to study the inclusion of OPC utilized free water from geo-polymerization reaction. It not only provide the reduction in the microcracks formation because of less shrinkage and also extra alkalinity such as calcium hydroxide which used catalyst the fly ash and activation solution reaction[4].

According to Amin Noushini (112) 2016 he proposed this study to examine the transport properties of class f fly ash based geopolymer concrete cured at different conditions. There are different programs involved in the curing temperature and duration period they are twelve different heat curing regimes including three temperatures such as 60, 75 and 90°c and four curing duration of 8, 12 and 24 hours it would be a cured ambient temperature were implemented to the specimen. This study showed that the proper curing condition of 75°c from 18-24 hours gained a GPC along with low volume of permeable voids and low sorptivity coefficient.[3]

### IV. CONCLUSION

This review paper incorporates with the current sustainable concrete containing a partial replacement of OPC with the cementitious materials. The durability properties such as sorptivity, immersed absorption, chloride ion penetration and volume of permeable voids of geopolymer concrete get adversely affected. The durability of concrete is also an important requirement for the performance of the structure in aggressive environments. Acid resistance is one of the essential properties for structural materials. Sulphate attack is known to produce significant degradation in concrete structures. Therefore, much attention was drawn to provide an adequate protection for concrete in contact with surroundings with high content of sulphate ions. Durability of alkali activated slag based geopolymer concrete has been reported to have a superior durability in aggressive environment as compared to OPC. The above discussion presents the durability of class F fly ash as binder component in producing ambient cured geopolymer concrete. One of the important steps of geopolymer synthesis is curing in dry or steam condition and thus till recently the research emphasis was on thermally cured geopolymer composites synthesized normally with one source material. The rate of capillary absorption of water by concrete is a function of penetrability of pore system, where for unsaturated concrete the rate of ingress of water or other liquids is largely controlled by absorption due to capillary rise. In this study the rate of water absorption of GPC are studied.

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