



# Analyse and investigate the geopolymers based concrete

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## Abstract

Geopolymer is a material which will be obtained by many scraps like soot, coming out from thermal power plants like iron as well as manganese production industry and acts as a virtuous replacement for cement. By using those disposable waste products we will decrease the effect of contamination to environment. At the same time, the material will be used to make the geopolymer concrete. Geopolymer mainly act as a replacement for cement. Since cement production causes the huge carbon-di-oxide emission to the environment and massive raw materials and energy are required to make as the product. The geopolymer concrete are made by using fly ash, ground granulated blast-furnace, fine aggregate, coarse aggregate, water as well as chemicals namely sodium silicates and sodium hydroxide. The chemicals helps to take polymerization reaction along with silicates, aluminates present in fly ash. By replacing the usage of cement by geopolymer material, the green house effects get decreases. The paper explores the influence of fly ash and ground granulated blast furnace slag is studied by casting the specimen for M15, M20, and M25 qualities of cement. This initial test is done on the materials used for casting the specimen. The specimens were casted for different grades. After the curing period the specimen's potency as well as resilience behavior of geopolymer cement are observed by conducting the various experiments such as compressive strength test, flexural strength, split tensile strength. Finally, the optimal content of geopolymer to be added for concrete is derived and that percentage will be useful for construction field.

## Introduction

Our country's growth is directly or indirectly represented by innovative construction of structures around the universe. The innovative construction which will comprises of usage of eco-friendly materials as well as the techniques implemented in it [1], [2]. Even though there will be many techniques are available to construct the structure, the material used for the construction plays a vital role. The materials commonly used for constructions are Concrete, Fine Aggregate, Coarse Aggregate, Concrete, H<sub>2</sub>O, Admixtures and so on. Among these, Concrete can be commonly used as a substantial material in civil Engineering construction, which may be used as RCC or PCC [3], [4]. In order to make the concrete, the main component used is Cement which will cause the carbon emission to the environmental and causes the huge pollution [5], [6]. Hence we have to use the material which is less harmful to the environment and easily available acts as a replacement of the cement.

Silica and alumina atoms react to form molecules that are chemically and structurally equivalent to a natural rock [7]. It shows a greater bonding property, better abrasion and high impact resistance with less vulnerable to chemical attack

[8], [9]. Sodium Silicates and Sodium Hydroxide helps to take polymerization reaction along with Silicates, Aluminates present in fly ash [10]. Davidovits coined the new word to this material as Geo-Polymer in 1978. Geo-polymer is an alkaline liquid which reacts with Silicone (Si) and Aluminium (Al) in by-product substance to produce binders. Combination of Sodium Hydroxide (NaOH) or Potassium Hydroxide (KOH) and Sodium Silicate causes Geopolymerization.[11]. The materials used to make the geopolymer concrete are Fly ash, GGBS, Sodium Hydroxide, Sodium Silicate, Fine Aggregate, Coarse aggregate as well as Water. These different percentages of substances were added to make the concrete of M15, M20 and M25 grade. The strength and durability test were conducted on those specimens [12], [13]. The usage of geopolymer reduces CO<sub>2</sub> emission there by benefits in diminishing the environmental impact caused by the construction industry. Study on the properties of the geopolymer concrete (GPC) was carried with a combination of flyash and ground granulated blast-furnace slag and it is observed that such concrete has strength alike to that of the Portland Cement Concrete with a better durability [14]. The results of geopolymer mortars are high when compared with conventional mortars in terms of compressive strength and flexural strength. The compressive strength, flexural strength and density of mortar increased with increase in GGBS content. In a research study by Amitkumar D.Raval and Dr. Indrajit N.Patel [15], on effective replacement of cement for establishing sustainable concrete, the cement has been replaced by ceramic waste powder in the range of 0%, 10%, 20%, 30%, 40% & 50% by weight for M-20 grade concrete Geopolymer concrete that gives strong durability as well as low in creep & shrinkage, it will also give resistance to temperature and Chemical Effects. The main Aims for this research are listed below.

1. The influence of Geo-polymer material in concrete is the primary study of this paper. The effect of Geo- Polymer materials were obtained by conducting the laboratory test.
2. Examine this Geo-polymer concrete's properties by conducting various strength tests.
3. Optimizing the percentage of Geo-polymer materials to be added for normal concrete to achieve maximum compressive strength
4. To test whether reinforcing polymer with concrete will improve its strength than its initial strength

**In order to study the effect of Geopolymer materials on the concrete the following methodology is used.**

#### *a) Preparation of specimen*

The effects of GGBS and Flyash in concrete were studied by making the specimen. The materials used for the Geopolymer manufacturing were tested as per [9] and the material properties are shown in Table 1. Based upon the material properties, the mix design were done to cast the specimen of specific grades. The material added in concrete are fly ash of 61.6%, GGBS of 12.4%, Sodium Hydroxide of 7.4% and Sodium Silicate of 18.6%. Among the materials the Fine aggregate and Coarse aggregate were taken as 30% and 70 % of the total aggregates respectively. These materials were mixed thoroughly for casting the specimens. To obtain mass of NaOH and sodium silicate solutions, the ratio of sodium silicate solution to NaOH solution was taken as 2.5. For the study the concentration of NaOH solution is taken as 8M. It was establish that the fresh Geo-polymer masonry mix was grey in colour and was cohesive. The amount of water in the mix played an important role on the behaviour of fresh mix.

#### *b) Casting of specimen*

For the experimental investigation in order to find out the strength behavior of the specimens were casted in form of cube, cylinders and beams respectively for a grade of M15, M20 and M25. The specimens were casted by mixing the materials by hand mixing. The aggregates (coarse and fine) were cleaned well before the batching process in order to remove the organic impurities. The material added in concrete are fly ash of 61.6%,GGBS of 12.4%, Sodium Hydroxide of 7.4% and Sodium Silicate of 18.6%.The materials quantity are taken by weight batching. Far away existing potable water was collected and used for mixing purpose along with raw materials. Based upon the standard size, the moulds were used. After the mixing of the raw materials used for Geopolymer concrete based on the mix design, the mixtures were transferred in to the appropriate moulds. The moulds were greased well before the pouring of concrete paste. The proper tamping of about 25 blows were done for three layer in order to remove the air and water present in the void of concrete matrix. The specimen was cured in the atmospheric temperature about one day. The very next day, the specimens were detached from the moulds and allowed to curing in water for 28days.

## Section snippets

### Testing of specimens

#### *a. Compressive strength*

In order to calculate out the compressive strength of OPC and geopolymer concrete the cubes were casted in the size of 150 mm×150 mm×150 mm. After the Curing period of the cubes were taken out from the curing tank and used for finding the strength behaviour. The compressive strength test is done as per [16]. The cubes are placed in compression testing machine (2000 kN). By applying the load gradually the specimen get failed at the particular load. That failure load...

### Results and discussion

The compressive strength of the geopolymer concrete for different grades like M15, M20 and M25 were investigated and compared the results with Normal Concrete for curing period of 7days, 14days and 28days. From the test results, it's found that the compressive strength behavior for the geopolymer concrete gets increases for the proportion of the materials used. The compressive strength achieved is the twice more than the grade of concrete in which the specimens are casted. The polymerization ...

### Conclusion

The behavior of Geopolymer Concrete is studied by adding fly ash, GGBS, sodium hydroxide, sodium silicate, coarse aggregate, fine aggregate with proportion. The results are shows that the Geopolymer Concrete gives the high strength in compare with the normal concrete. The admixture proportion used for the present study fly ash of 61.6%, GGBS of 12.4%, Sodium Hydroxide of 7.4% and Sodium Silicate of 18.6% makes the geopolymer concrete well in strength and durability. The proportion of chemical...

### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper....

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