Study on Strength and Durability of Geopolymer Concrete using GGBS and Artificial Sand

[1]Hiten M Gawad, [2]Krupa S Pimple, [3]Sushant N Kanhat, [4]Mehul L Parmar
[1]Research Scholar, MIT College of Management, Loni-Kalbhor, Pune, Maharashtra, India.
[2]Research Scholar, JSPM Imperial College of Engineering and Research, Wagholi, Pune, Maharashtra, India.
[3][4] Research Scholars, St John College Of Engineering and Management, Palghar, Maharashtra, India.

Abstract : This paper presents the research on Geopolymer Concrete blended with Fly ash, Artificial sand and mineral admixtures such as Ground Granulated Blast Furnace Slag (GGBS) and Alkaline Liquids (Sodium Hydroxide and Sodium Silicate), which gives us an alternative to ordinary Portland cement. In this paper result of compressive strength and studies on durability of Geopolymer concrete having Molarity 8, 10, 12, 14, 16 with Alkaline liquid to Fly ash ratio as 0.35 and 0.4 are shown. This study was attempted to know the compressive strength and the resistance of Geopolymer concrete to acids (Sulphuric and Hydrochloric). The specimen cube of size 150 x 150 x 150 mm side was casted which had GGBS as 20% replacement of fly ash. For the compressive strength the cubes were kept for oven drying for about 24 hours and some cubes were kept in Sundry for seven days. For the Durability study the specimens were immersed in the solution of 5% concentrated Sulphuric acid and Hydrochloric acid for a duration of 28 days and the change in weight of the specimens and the compressive strength were evaluated.
The exposure to Sulphuric acid and Hydrochloric acid showed a slight damage to the surface of the specimen.

Key Words: Alkaline Liquids, Compressive Strength, Durability, Fly ash, Geopolymer, GGBS.

I. INTRODUCTION

If we use cementatious materials in replacement for the cement in concrete, it will play an important role from Environment point of view, which will help to control Greenhouse effects and reduction in global temperature. A French material scientist Davidovits [1], [6] in 1978 proposed that, by using Alkaline liquids and the material containing alumina and silica, a binder material can be produced by polymerization process. Durability property of concrete is the one which evaluates its life. There are many environmental factors among which acid attack is most threatening one. Bakharev T. [2] Studied fly ash based geopolymer concrete and also its resistance to 5% sulfuric acid and concluded that it has better resistance to acid attack. Allahverdi Ali and Skavara [3], [4] studied mechanism on corrosion of Geopolmer concrete in high as well as low concentration of sulphuric acid. This paper is aimed to know the compressive strength of geopolymer concrete having different Molarity and response of fly ash based geopolymer concrete to 5% sulfuric acid and 5% hydrochloric acid solution for 28 days. The studies were made to determine compressive strength of 1 day cured oven dried sample, 7 days ambient cured sample and resistance against sample cured for 28 days in sulfuric and hydrochloric acid. The results shall be beneficial to figure out the applicability of geopolymer materials for use in acid environments.

II. EXPERIMENTAL PROGRAM

Alkaline Liquid

The mixing of sodium hydroxide and sodium silicate was done 24 hours prior for proper mixing and reaction. The sodium hydroxide solution is prepared by mixing sodium hydroxide pellets with water in 8M, 10M, 12M, 14M, 16M concentration, and then this solution is mixed with sodium silicate and used. The ratios taken were 0.35 and 0.4, the sodium hydroxide with 98% purity were commercially available in pallet form.

Fly Ash

The Fly ash was obtained from Reliance Thermal Power Plant, Dahanu (Maharashtra). It was a Low-Calcium (ASTM Class F) Fly ash.

Fine Aggregate

The fine aggregate used was crushed sand and it was obtained from a local quarry. The specific gravity of crushed sand was 2.56.

Coarse Aggregate

The coarse aggregate passing through 20mm and retaining on 12.5mm IS sieve were used 60% of total coarse aggregate and the specific gravity was 2.69, the remaining 40% were the aggregates passing through 16mm and retaining on 4.75mm IS sieve and the specific gravity was 1.43.

Geopolymer Concrete

Table 1. Mix proportions of constituent materials (kg/m³) (For 8 Molar) (Ratio 0.35)

Materials		Mass (kg/m³)
Coarse aggregate	20mm	776.16
	10mm	517.44
Fine aggregate		554
Fly ash (low-calcium ASTM class F)		327.11
Ground granulated blast furnace slag (GGBS)		81.78
Sodium Silicate solution		102.22
Sodium Hydroxide solution		40.89

Mixing, Casting and Curing

All the dry materials such as coarse aggregates, fine aggregates, fly ash, GGBS are mixed together properly then the alkaline liquid solution which is made 24 hours prior is mixed with 2% plasticizer to increase the workability and then poured in the dry mixture and mixed for another four minutes [4], [5], [7]. Then the molds are oiled crucially and then filled in three layers and tempered for 25 times by standard compaction rod [6]. This mold is kept on vibrator for some time for proper compaction. The specimens were allowed to set for 46 hours and de-molded the specimens are kept in oven for 24 hours at 75ºc, some

of them are kept for sun drying for 7 days and the other are kept in sulphuric and hydrochloric acid.

III. TESTS AND RESULTS

The compressive strength test was performed for the hardened concrete on C.T.M. The results of oven dried sample, sun dried sample and the sample immersed in acid are given in the table below

Sr no	Molarity	Alkaline Liquid/ Fly ash Ratio	Compressive Strength N/mm²			
			Oven Dry 24 hours at 75°	Sun Dry 7 days	Immersed in acid for 28 days	
					H_2SO_4	HCL
1.	8M	0.35	44.93	32.34	33.37	35.47
2.	8M	0.4	48.04	36.18	37.42	34.76
3.	10M	0.35	56.22	43.45	43.87	44.44
4.	10M	0.4	53.69	45.69	49.60	45.20
5.	12M	0.35	64.93	50.36	49.11	48.76
6.	12M	0.4	66.76	56.04	53.78	57.33
7.	14M	0.35	67.69	60.84	60.04	60.36
8.	14M	0.4	69.69	63.51	62.53	61.87
9.	16M	0.35	70.31	66.09	64.76	63.96
10	16M	0.4	70.71	66.31	65.02	66.58

IV. CONCLUSION

1. The Experiment results stated that as the Molarity of Geopolymer Concrete increases there is increase in Compressive Strength.
2. By using the method of Ambient curing for 7 days the target compressive strength can be achieved and hence can be used for structural application.
3. As the Alkaline liquid to Fly Ash ratio increases there is increase in strength of Geopolymer Concrete.
4. As the Water to Geopolymer ratio increases the compressive strength of Geopolymer Concrete decreases.
5. As the Compressive Strength obtained is very high this concrete can be used as High Strength Concrete.
6. According to the Durability results obtained the specimen is affected to Sulphuric as well as Hydrochloric Acid to a very small extent.
7. This stated that this concrete can withstand the chemical environment and may be very helpful in the precast construction industry.

V. REFERENCE

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