

EFFECT OF AGGREGATE SIZE AND SILICA FUME ON THE WORKABILITY OF GEOPLOYMER CONCRETE

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Abstract

As per the changing times, the emission of Carbon from different aspects are on a verge of rise, as the time passes by the rate goes on increasing, production of cement also adds up in the emission of carbon, This experimentation is a step taken to decrease the carbon emission from concrete, By replacing Geo-polymers in concrete in place of cement by using waste materials as binders, & implementing various curing techniques to provide strength to our units.

Keywords: Geopolymer, Fly ash, Alkaline Solution, Replacing Cement, Reduce Carbon emission in atmosphere

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1. INTRODUCTION

Geopolymers are new materials for fire and heat-resistant coatings and adhesives, medicinal applications, high-temperature ceramics, new binders for fire-resistant fiber composites, toxic and radioactive waste encapsulation and new cements for concrete.

The properties and uses of geopolymers are being explored in many scientific and industrial disciplines: modern inorganic chemistry, physical chemistry, colloid chemistry, mineralogy, geology, and in other types of engineering process technologies.

Geopolymers are part of polymer science, chemistry and technology that forms one of the major areas of materials science.

Polymers are either organic material, i.e. carbon-based, or inorganic polymer, for example silicon-based.

The organic polymers comprise the classes of natural polymers (rubber, cellulose), synthetic organic polymers (textile fibers, plastics, films, elastomers, etc.) and natural biopolymers (biology, medicine, pharmacy). Raw materials used in the synthesis of silicon-based polymers are mainly rock-forming minerals of geological origin, hence the name: geopolymer.

2. MATERIALS

This includes materials and their specifications the tests performed on geopolymer concrete as per relevant standards and details of making and testing of geopolymer concrete.

On the basis of literature review and trails experimental program was derived. It specifies the materials (such as fly ash), mixture proportion, parameters such as ratio of alkaline solution to source material, methods of curing, tests to be performed, period of testing.

The materials used for making fly ash-based geopolymer concrete specimens are fly ash as the source material, aggregates, alkaline solution, and water.

Table -1: Chemical Properties of Fly Ash

Chemical composition weight %	Fly Ash
SiO ₂	53.79
Al ₂ O ₃	32.97
Fe ₂ O ₃	5.51
CaO	1.84
MgO	0.92
Na ₂ O	0.37
K ₂ O	1.76
TiO ₂	2.10
SO ₃	0.46
P ₂ O ₅	0.15

Table -2: Sieve analysis of Fine Aggregate

Sieve	Retain Gm	Retain %	Cumulative %	Passing %
10 mm	0	0	-	10
4.75 mm	6	3	3	97
2.36 mm	38	19	21	79
1.18 mm	54	27	48	52
600	31	15.5	63.5	36.5
300	43	21.5	85	15
150	10	5	90	10
Pan	20	10	100	0

Table -3: Sieve analysis of Coarse Aggregate

COARSE AGGREGATE 10 MM				
Sieve	Retain Gm	Retain %	Cumulative %	Passing %
12.5	16	0.8	0.8	99.2
10	212	10.6	11.4	88.6
4.75	1445	72.25	83.65	16.35
2.36	308	15.4	99.05	0.95

2.1 Alkaline Solution

The alkaline liquid used was a combination of sodium silicate solution and sodium hydroxide solution. The sodium silicate solution ($\text{Na}_2\text{O}=13.7\%$, $\text{SiO}_2=29.4\%$, and $\text{water}=55.9\%$ by mass) was purchased from a local supplier in bulk. The sodium hydroxide (NaOH) in flakes or pellets from with 97%-98% purity was also purchased from a local supplier in bulk. The NaOH solids were dissolved in water to make the solution.

2.2 Silica Fume

Silica fume is a byproduct of producing silicon metal or ferrosilicon alloys. One of the most beneficial uses for silica fume is in concrete. Because of its chemical and physical properties, it is a very reactive pozzolan. Concrete containing silica fume can have very high strength and can be very durable. Silica fume is available from suppliers of concrete admixtures and, when specified, is simply added during concrete production. Placing, finishing, and curing silica-fume

concrete require special attention on the part of the concrete contractor.

3. MIX DESIGN

Table -3: Mix Design For One Beam

Materials	Weight in kg
Fly Ash	2.51
Fine Aggregate (sand)	2.76
Coarse Aggregate (10mm)	1.86
Coarse Aggregate (20mm)	1.86
Silica Fume	0.93
Alkaline Solution	
NaOH Flakes	0.21
Water	0.26
Na_2SiO_3	1.19

Table -4: Different Proportion for Test

M30	G1	G2	G3	G4
FLY ASH	2.51	2.51	2.51	2.51
F.A	2.76	2.76	2.76	2.76
C.A. (10mm)	1.86	2.232	1.488	3.72
C.A.(20mm)	1.86	1.488	2.232	-
SILICA FUME	0.93	0.93	0.93	0.93
NaOH	0.21	0.21	0.21	0.21
WATER	0.26	0.26	0.26	0.26
Na_2SiO_3	1.19	1.19	1.19	1.19

M30	G5	G6	G7	G8
FLY ASH	3.69	3.69	3.69	3.69
F.A	2.76	2.76	2.76	2.76
C.A. (10mm)	1.86	2.232	1.488	3.72
C.A.(20mm)	1.86	1.488	2.232	-
NaOH	0.21	0.21	0.21	0.21
WATER	0.26	0.26	0.26	0.26
Na_2SiO_3	1.19	1.19	1.19	1.19

4. TEST PROCEDURE

4.1 Slump Test



To determine the workability of concrete mix by slump test conducted by as per IS 1199-1959. The internal surface of the mould thoroughly cleaned and freed from superfluous moisture than mould placed on a smooth, horizontal, rigid and nonabsorbent surface. The mould was filled in four layers, each approximately one-quarter of the height of the mould. Each layer was tamped with twenty-five strokes of the rounded end of the tamping rod. The bottom layer tamped throughout its depth. After the top layer has been rodded, the concrete was struck off level with a trowel or the tamping rod, so that the mould is exactly filled. The mould removed from the concrete immediately by raising it slowly and carefully in a vertical direction. This allows the concrete to subside and the slump shall be measured immediately by determining the difference between the height of the mould and that of the highest point of the specimen being tested.

4.2 Compacting Factor Test



The concrete was placed gently in upper hopper, using the hand scoop. The hopper was filled level with its brim and trap-door was opened so concrete falls in to lower hopper. Than the trap door of second hopper was opened and concrete was allowed to fall in cylinder. The excess concrete above the top of cylinder was removed by towel. The weight of concrete was measured and compare that with the weight of concrete was fully compacted in same cylinder. And the ratio of both known as compaction factor

Table -4: Result Analysis of Tests Procedure

	G1	G2	G3	G4
Slump Test	70mm	66mm	68mm	73mm
Compacting Factor Test	0.69	0.65	0.68	0.76
	G5	G6	G7	G8
Slump Test	81mm	75mm	79mm	86mm
Compacting Factor Test	0.83	0.79	0.86	0.89

5. CONCLUSIONS

- As the increasing Ratio of 10mm Dia. Aggregate/ 20mm Dia. Aggregate workability Geopolymer Concrete Increasing.
- Higher the percentage of Silica fume will decrease the workability of Concrete

RESULTS

Highest Workability we get at 100% with 10mm Aggregate and 0% of Silica Fume.

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