IARJSET

ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 7.105 ⁜ Vol. 9, Issue 6, June 2022

DOI: 10.17148/IARJSET.2022.9643

Alkaline Activation of Geopolymer Concrete Using Sodium Silicate and Sodium Hydroxide Solution

Rohan N. Patil[1], Prof. Yogesh Gawande[2], Prof. Kasliwal S. S.[3]

[1]PG Student, Department of Civil Engineering, Snd College of Engineering & Research Center Babhulgaon, Nashik, India.

[2]Professor, Department of Civil Engineering, Snd College of Engineering & Research Center Babhulgaon, Nashik, India.

[3]Professor, Department of Civil Engineering, Snd College of Engineering & Research Center Babhulgaon, Nashik, India

Abstract: With the growing need for construction materials, Portland cement manufacturing increases year after year. The global production of Portland cement is increasing by 3% every year. As a result, the amount of carbon dioxide released into the atmosphere during the manufacture of Portland cement is increasing. The manufacture of Portland cement emits roughly 1.35 billion tonnes of greenhouse gases each year, accounting for about 7% of overall greenhouse gas emissions. Furthermore, after aluminium and steel, Portland cement is one of the most energy-intensive construction materials. Cement, fine aggregate, coarse aggregate, and water are all used for concrete. Concrete is the world's second most consumed substance, behind water, due to its importance in the building of infrastructure. Because concrete is such a versatile material that it may be used for a wide range of applications in a variety of environments, regular concrete may not provide the desired quality, performance, or durability. By substituting concrete with suitable pozzalonic material, it is also possible to minimise construction costs and improve concrete performance without losing its original features. This article examines the use of ground granulated blast furnace slag in place of cement (GGBS). The main objective of this study is to investigate the strength and durability parameters of geopolymer concrete for concentration of NaOH in terms of molarity (M). for each mix sizes of cubes, were casted and tested. For strength at the age of 4,8,12,18,24 hours and for durability at the age of 30 days.

KEYWORD: Granulated blast furnace slag (GGBS, Molarity (M).

I. INTRODUCTION

Concrete is a frequently utilized man-made construction material all over the world. Concrete offers various advantages over other construction materials, including abundant resources, ease of operation, mechanical qualities, durability, and inexpensive production costs. Concrete can be widely used in civil engineering because of these qualities. Apart from these benefits, concrete has significant drawbacks, such as high energy and raw material consumption, pollution, and so on, which detract from its image as a sustainable material. The significant amount of carbon dioxide gas discharged into the atmosphere has prompted a study of Portland cement manufacturing. For every tonne of Portland cement produced, one tonne of carbon dioxide is released into the atmosphere due to the decarbonation of limestone in the kiln during the manufacturing process. The following chemical reaction demonstrates this.

$$5CaCO_3+2SiO_2 \rightarrow 3CaO.SiO_2+2CaO.SiO_2+5CO_2$$

Reducing the usage of Portland cement in concrete and replacing it with by-product materials such as fly ash, silica fume, powdered granulated blast furnace slag, and rice husk ash, for example, has environmental benefits. Fly ash, which is mostly silicon and aluminum, has a lot of potential as a cement substitute in concrete. Because concrete manufactured with this type of industrial water is environmentally benign, it is referred to as "green concrete."

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁜ Impact Factor 7.105 ⁜ Vol. 9, Issue 6, June 2022

DOI: 10.17148/IARJSET.2022.9643

II. LITERATURE REVIEW

1. **Patankar S.V et al. (2018),** The impact of duration and temperature curing on compressive strength of fly ash based geopolymer concrete was investigated, and it was discovered while investigating the effect of sodium hydroxide concentration on compressive strength of fly ash based geopolymer concrete that the compressive strength of geopolymer concrete increases with increasing sodium hydroxide solution concentration for all temperatures, however the rate of gain of strength at well above 60o C just isn't very significant.
2. **B. SivaKonda Reddy, J. Varaprasad and K. Naveenkumar Reddy [8],** Higher concentrations of sodium hydroxide (in the range of 10 M to 16 M) solution lower the workability of geopolymer concrete, resulting in a higher compressive strength. For a given concentration of NaOH solution, the compressive strength of a concrete increases slightly with age. The addition of a high-range water reduction admixture containing 1.5 percent fly-ash (by mass) had no effect on fresh geopolymer concrete's compressive workability.

3. **Ukesh Praveen P and Srinivasan K (2017),** The contribution of GGBS helps self-compacting geopolymer concrete achieve high compressive strength at ambient room temperature, according to a study of literature on self-compacting geopolymer concrete. In comparison to fly ash-based self-compacting geopolymer concrete, GGBS demonstrated higher compressive strength when curing at room temperature. Preparing sodium hydroxide and sodium silicate solutions at least 24 hours ahead of time is advised.

4. **Zhang H. Y. et al. (2018),** According to their experimental findings on the bond behavior of geopolymer concrete and rebar, geopolymer concrete showed considerable temperature-induced bond strength degradation. When exposed to high temperature above 300 C, bond strength of geopolymer concrete was found to decrease at the same rate as splitting tensile strength with temp, but at a faster rate than compressive strength.

III. OBJECTIVE OF WORK

A. The main Objective of this project is to develop the geopolymer mortar using fly ash as source material instead of cement, and use as alternative binder to cement.

B. To conduct the experimental work and to study the influence of- (Na_2SiO_3 + NaOH)/Fly ash ratio, Concentration of NaOH in terms of molarity.

C. To study the mechanical properties of GGBS concrete.

D. Compare the compressive strength of p63 and p83.

IV. METHODOLOGY

- LITERATURE REVIE
- PROJECT IMPLEMENTATION
- MATERIAL SELECTION AND STUDY OF MATERIALS

- DETERMINE THE EXPERIMENTAL PARAMETER
- TO FIX UP THE RANGE OF SOLUTIONS AND CONCENTRATIONS NaOH
- PRODUCTION OF GEOPOLYMER MORTAR MIXES AND RESULT

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⋇ Impact Factor 7.105 ⋇ Vol. 9, Issue 6, June 2022

DOI: 10.17148/IARJSET.2022.9643

V. EXPERIMENTAL STUDY:

Effect of various parameters on compressive strength of geopolymer concrete.

Table 1.1 to 1.4 gives the effects of solution-to-fly ash ratio, concentration of Sodium hydroxide, temperature and duration of heating on the compressive strength and alkalinity of geopolymer mortar. In the table, 2nd column shows the identification of fly ash-based geopolymer mixes, in which F indicates fly ash mortar, J indicates the solutions-to-fly ash ratio, and M indicates the concentration of NaOH flakes in a liter of distilled water in terms of molarity. For example, FO.45R6M indicates fly ash mortar produced by using solutions-to-fly ash ratio of 0.45 with 2.91M NaOH solution. (In the experimental work, it is difficult to prepared exact quantity of 1-liter solution. Therefore, instead of preparing 1-liter solution, required quantity of flakes of NaOH were dissolved in a liter of distilled water and from the laboratory measurement, molarity was found. 3rd column shows the solution-to-fly ash ratio. 4th column shows the concentration of NaOH solution in terms of molarity. 5th and 6th column show the temperature and its duration of heating respectively. 7th column shows the compressive strength of geopolymer mortar. 8th column indicates the alkalinity of geopolymer mortar in terms of pH value, checked after breaking the mortar cubes for compression.

A. MATERIALS USED

- **Ground granulated blast furnace slag (GGBS)- Pozzocrete 63, Pozzocrete 83.**
- **NaoH- Sodium Hydroxide**
- **Na2SiO3- Sodium Silicate**
- **Coarse Aggregates**
- **Fine Aggregates**
- **Cube Casting:** For concrete cube compression testing, 150mmx150mmx150mm size cubes were casted. Using a compression testing machine, the cubes were tested after 7 and 28 days of curing.

Fig.1 Casting Of Cubes

B. TESTING OF CUBES

Compressive strength of cement mortar was tested after 7 days and 28 days of curing as per IS 4031 (part -VI)-1981. Three cubes were tested for each curing period. Similarly, the compressive strength of geopolymer mortar was tested after heating the mortar cubes in a particular temperature for particular duration. Remaining procedure is similar to testing of cement mortar.

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588

International Advanced Research Journal in Science, Engineering and Technology

ISO 3297:2007 Certified ⁂ Impact Factor 7.105 ⁂ Vol. 9, Issue 6, June 2022

DOI: 10.17148/IARJSET.2022.9643

Fig.2 Compressive Strength Testing Machine

Fig.3 Compressive Strength of Cubes

VI. RESULTS AND FINDINGS

Table: 1.1 Compressive Strength of Geopolymer Mortar for Solution for Solution/Fly ash Ratio of 0.35 at Various Concentration of NaOH Solution and Pozzocreate-63.

Sr.No.	Identification Mark	(Na_2Sio_3 +NaOH)/ Fly ash	Conc. Of NaOH, M	Temp., Time °C	Curing Time, Hrs.	Comp. Strength, MPA
1	F0.35J6M	0.35	6	90	4	6.10
2	F0.35J8M	0.35	8	90	4	8.10
3	F0.35J10M	0.35	10	90	4	13.33

Table: 1.2 Compressive Strength of Geopolymer Mortar for Solution for Solution/Fly ash Ratio of 0.4 at Various Concentration of NaOH Solution and Pozzocreate-63.

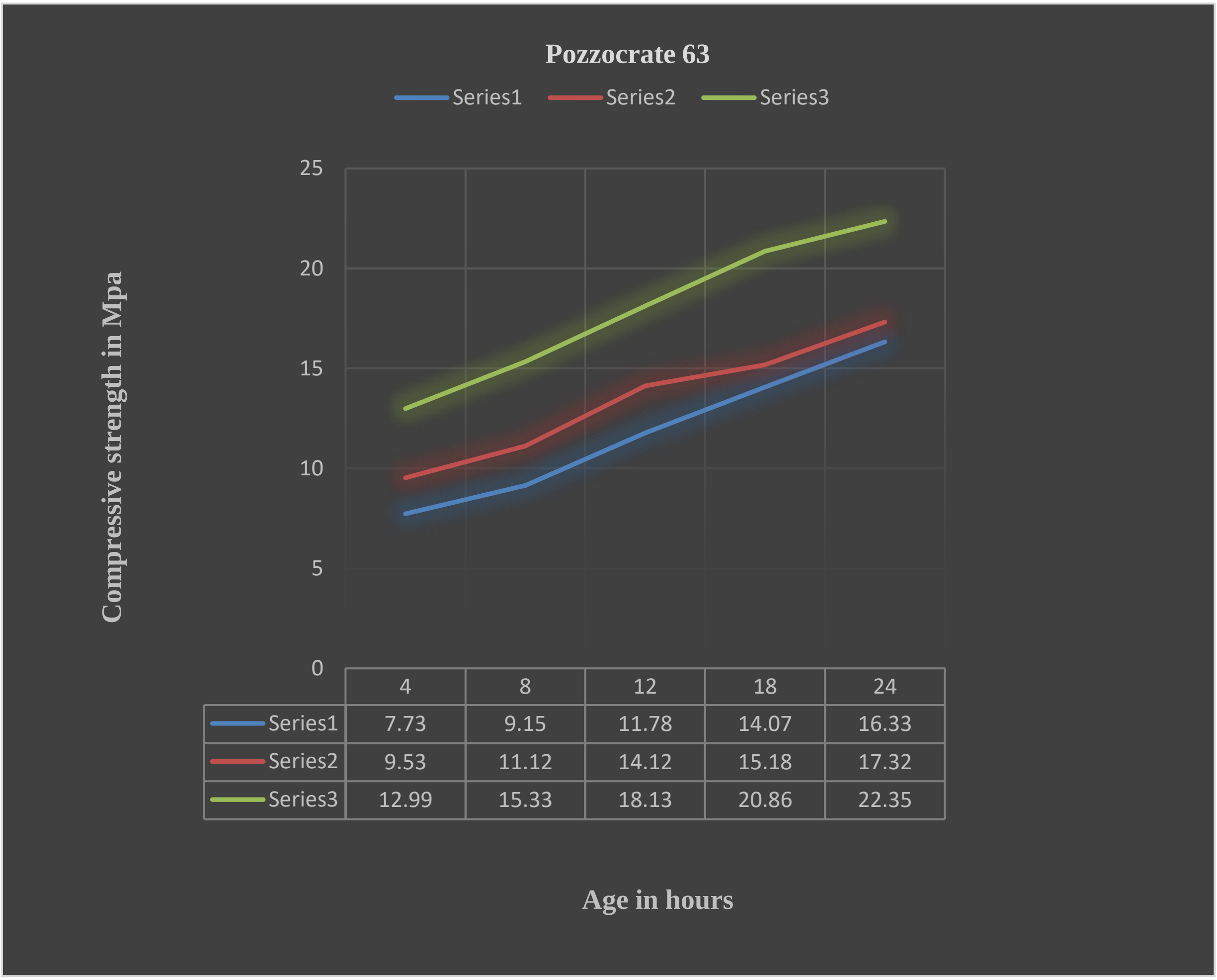
Sr. No.	Identification Mark	(Na_2Sio_3 +NaOH)/ Fly ash	Conc. Of NaOH, M	Temp., Time °C	Curing Time, Hrs.	Comp. Strength, MPA
1	F0.4J6M	0.4	6	90	4	7.73
2	F0.4J8M	0.4	8	90	4	9.53
3	F0.4J10M	0.4	10	90	4	12.99

Table: 1.3 Compressive Strength of Geopolymer Mortar for Solution for Solution/Fly ash Ratio of 0.4 at Various Concentration of NaOH Solution and Pozzocreate-63.

Sr.No.	Identification Mark	(Na_2Sio_3 +NaOH)/ Fly ash	Conc. Of NaOH, M	Temp., Time °C	Curing Time, Hrs.	Comp. Strength, MPA
1	F0.4J6M	0.4	6	90	8	9.15
2	F0.4J8M	0.4	8	90	8	11.12
3	F0.4J10M	0.4	10	90	8	15.33
4	F0.4J6M	0.4	6	90	12	11.78
5	F0.4J8M	0.4	8	90	12	14.12
6	F0.4J10M	0.4	10	90	12	18.13
7	F0.4J6M	0.4	6	90	18	14.06
8	F0.4J8M	0.4	8	90	18	15.18
9	F0.4J10M	0.4	10	90	18	20.86

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified ⋇ Impact Factor 7.105 ⋇ Vol. 9, Issue 6, June 2022
DOI: 10.17148/IARJSET.2022.9643

10	F0.4J6M	0.4	6	90	24	16.33
11	F0.4J8M	0.4	8	90	24	17.32
12	F0.4J10M	0.4	10	90	24	22.35



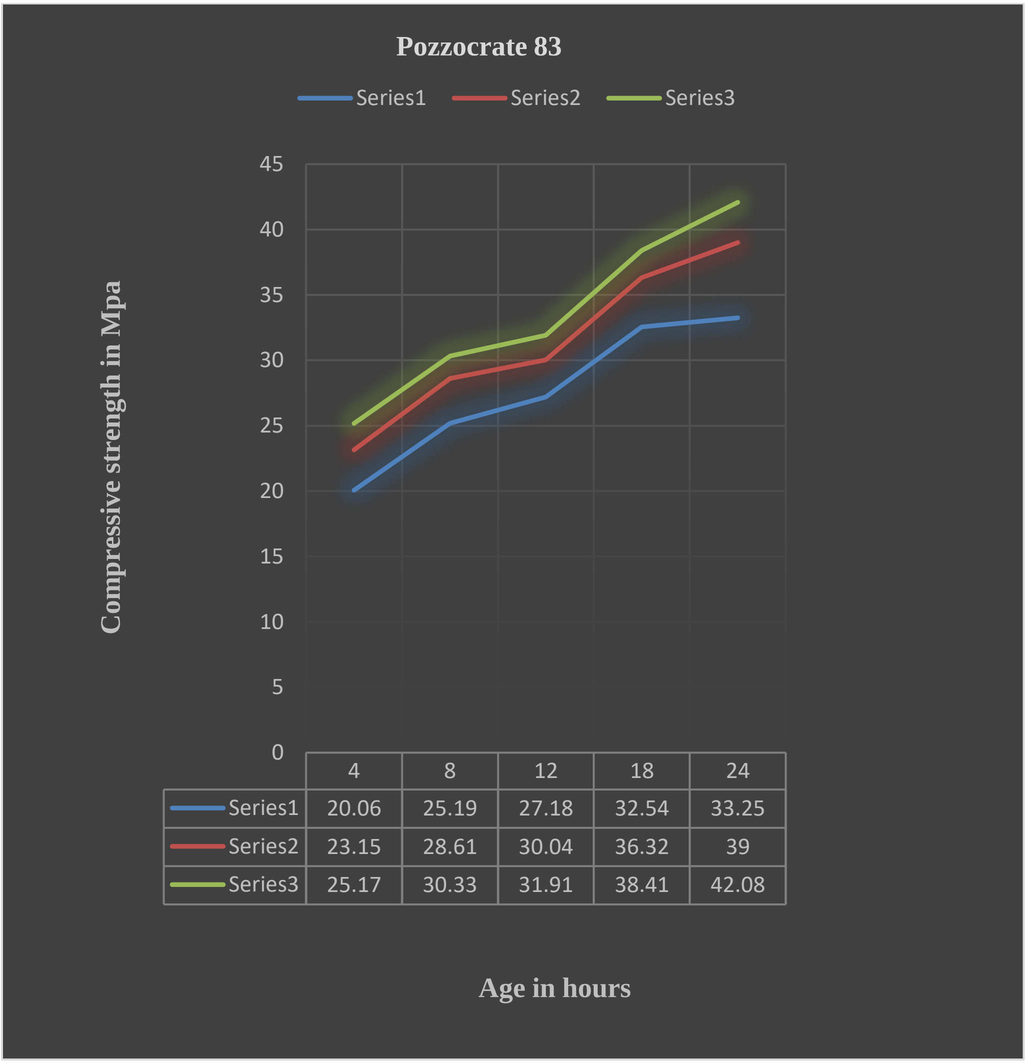
Graph 1: Compressive Strength of pozzocrete 63.

Table: 1.4 Compressive Strength of Geopolymer Mortar for Solution for Solution/Fly ash Ratio of 0.35 at Various Concentration of NaOH Solution and Pozzocreate-83.

Sr.No.	Identification Mark	(Na_2Sio_3 +NaOH)/ Fly ash	Conc. Of NaOH, M	Temp., Time °C	Curing Time, Hrs.	Comp. Strength, MPA
1	F0.4J6M	0.4	6	90	4	20.06
2	F0.4J8M	0.4	8	90	4	23.15
3	F0.4J10M	0.4	10	90	4	25.17
4	F0.4J6M	0.4	6	90	8	25.19
5	F0.4J8M	0.4	8	90	8	28.61
6	F0.4J10M	0.4	10	90	8	30.33
7	F0.4J6M	0.4	6	90	12	27.18
8	F0.4J8M	0.4	8	90	12	30.04
9	F0.4J10M	0.4	10	90	12	31.91
10	F0.4J6M	0.4	6	90	18	32.54

IARJSET ISSN (O) 2393-8021, ISSN (P) 2394-1588
International Advanced Research Journal in Science, Engineering and Technology
ISO 3297:2007 Certified ⁘ Impact Factor 7.105 ⁘ Vol. 9, Issue 6, June 2022
DOI: 10.17148/IARJSET.2022.9643

11	F0.4J8M	0.4	8	90	18	36.32
12	F0.4J10M	0.4	10	90	18	38.41
13	F0.4J6M	0.4	6	90	24	33.25
14	F0.4J8M	0.4	8	90	24	39
15	F0.4J10M	0.4	10	90	24	42.08



Graph 2: Compressive Strength of pozzocrete 83.

VII. CONCLUSION:

1) The flow of geopolymer mortar increases with increase in solution to fly ash ratio up to 0.40.
2) Higher concentration of sodium hydroxide solution in terms of molarity, results in higher compressive strength of fly ash based geopolymer mortar.
3) Compressive strength geopolymer mortar at solution to fly ash ratio of 0.35 which 10 M NaOH concentration is 3 times greater than that of 6 M sodium hydroxide solution with same water to geopolymer binder ratio.
4) Compressive strength of P-83 is found to be greater than P-63.
5) Higher the ratio of alkaline solution to fly ash by mass, higher is the compressive strength of fly ash based geopolymer mortar. But up to solution to fly ash ratio at 0.4 beyond this ratio, mix is very viscous and flowable and a problem in compaction and retard the setting and strength.

DOI: 10.17148/IARJSET.2022.9643

REFERENCES

1. Radhakrishna, A. Shashishankar and B.C.Udayshankar ”Analysis and assasement of strength development in fly ash based compressed geopolymer concrete”
2. R.V. Ranganath and M. Saleh “Some optical value in goepolymer concreteincorporating fly ash”
3. A Fernandez-Jimenez and A. Palomo “alkaline activation of fly ashes manufacturing of concrete not containing Portland cement”
4. Nguyen Van chanh. Bui Dang Trung, Dang Van Tuan “Recent Research Geopolymer Concrete.
5. Peter Duxson,JohnL.Provis,GrantC.Lukeyetal ‘The Role of Inorganic Polymer Technology in the Development of Green Concrete”
6. Nguyen Van Chanh, Bui Dang Trung, Dang Van Tuan “Recent Research Geopolymer Concrete”
7. Mohd Mustafa Al Bakri, H.Mohammed et al “concrete without Portland Cement Review on fly ash-based geopolymer ”
8. B.SivaKonda Reddy, J.Varaprasad and K.Naveenkumar Reddy “Strength and workability of low lime fly-ash based geopolymer concrete ”
9. J. Temuujin, R.P.Williams, A,.Van, et al. "Effect of mechanical activation of fly ash on the poperties of geopolymerscuried at ambient temperature"
10. Daniel LY. Kong, Jay G. Sanjayan."Damage behaviour of geopolymer composites expossd to elevated temperatures"