G. S. Patil, 2021, 9:3
ISSN (Online): 2348-4098
ISSN (Print): 2395-4752

The Effect of Change in Molarity of Sodium Hydroxide on Geopolymer Concrete

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Abstract- The objectives of the present research is to appreciate the effect of Fly ash based Geopolymer concrete. Collecting the low calcium fly ash from a thermal power plant and this Fly ash used are lignite coal based and falls under class F category. This fly ash reacts with alkaline solution Sodium hydroxide (e.g., NaOH) and Sodium Silicate (Na2SiO3) to form a gel which binds the fine and coarse aggregates. An attempt has been made to find out strength of the Geopolymer concrete at different molarity and temperature at 100 ℃. Concrete cubes of size 150 x 150 x 150 mm were prepared and cured under oven dry curing for 24 hours. The compressive strength was originate out at 7 days. The results are compared. The optimal mix is Fly ash: Fine aggregate: Coarse aggregate (1:1.5:3.3) with a solution (NaOH & Na2SiO3 combined together) to fly ash. High and Premature strength was obtained in the Geopolymer concrete mix. Strength of Geopolymer concrete which will be useful to the researchers and manufacturers.

Keywords:- Geopolymer, Alkaline Solutions, Ambient curing, Molarity.

I. INTRODUCTION

The Geopolymer concrete invented by French Professor Davidovits in 1978. The Geopolymer depend on thermally activated by-products like fly ash or slag to provide a source of silicon (Si) and aluminium (Al). These Silicon and Aluminium is dissolved in an alkaline activating solution and subsequently polymerizes into molecular chains and become the binder.

Professor B.Vijaya Rangan(2008), Curtin University, Australia, stated that, the polymerization process involves a substantially fast chemical reaction under alkaline conditions on silicon-aluminium minerals that results in a three-dimensional polymeric chain and ring structure. The type of alkaline liquid used plays an important role in the polymerisation process. Sodium hydroxide (NaOH) and sodium silicate (Na2SiO3) this alkaline liquids and water used in geopolymerisation.

In 2005, Fernandez-Jiménez and Palomo studied the effect of an alkaline liquid on the mechanical strength of fly ash-based mortar. They stated that the mechanical strength of mortar increases when water glass (Na2SiO3) is added to NaOH, compared with using only NaOH. The addition of water glass increases the Si/Al and Na/Al ratios, resulting in increased formation of N-A-S-H (sodium alumino silicate gel) which indicates greater strength. Showed that the compressive strength of fly ash- based Geopolymer concrete can be improved by either increasing the concentration (in molar terms) of the sodium hydroxide solution.

The temperature at curing is very imperative, and depending upon the source materials and triggering solution, heat often must be applied to facilitate polymerization, although some systems have been developed that are designed to be cured at 100° C temperature.

International Journal of Science, Engineering and Technology

An Open Access Journal

The main fact is that production of cement add to the pollution of environment is a well-known fact to civil engineers and environmentalists. The large-scale production of cement is affectation environmental problems on one hand and unobstructed depletion of natural resources on the other hand. Each tone of Portland cement production results in loading about one tone of CO2 into the environment. If the mix design process for Geopolymer concrete can become accepted and viewed as practically useful as that of ordinary Portland cement concrete, then it has the potential to become used on a more widespread basis. Thus Geopolymer is an innovative technique and eco-friendly to environment.

II. EXPERIMENTAL WORK

1. Materials:

In the planned mix proportioning method, low calcium processed fly ash of thermal power plant was used as source material. The laboratory grade sodium hydroxide in flake form and sodium silicate in gel form solutions are used as alkaline activators. Locally offered river sand is used as fine aggregate and available 20 mm and 12.5 mm sizes coarse aggregates.

1.1 Fly Ash:

Quantity and fineness of fly ash plays a vital role in the activation process of Geopolymer. It was previously find out that the strength of Geopolymer concrete increases with increase in quantity and fineness of fly ash. Similarly, higher fineness shows higher workability and strength with early duration of heating. So, the main importance is given on quantity and fineness of fly ash in the development of mix proportioning procedure of Geopolymer concrete. The different parameters in fly ash in Table no. 1

Table No. 1 ifferent parameters of fly ash.

Sr.No.	Parameters	Value in %
1.	Alumina(Al2O3)	22.86
2.	Silica(SiO2)	77.15
3.	Iron(Fe2O3)	0.65
4.	Calcium(CaO)	1.60
5.	Magnesium(MgO)	0.16
6.	Potassium(K2O)	0.031
7.	Sodium(Na2O)	0.027
8.	Sulphur(SO3)	0.72

1.2 Alkaline Solutions:

In the present investigation, sodium based alkaline solutions are used. The both sodium hydroxide (NaOH) and sodium silicate solutions are used for the activation of fly ash based Geopolymer concrete. It is observed that the compressive strength of Geopolymer concrete increases with increase in concentration of sodium hydroxide (NaOH) and and sodium silicate(Na2Sio3) solution with increased viscosity of fresh mix.

Due to increase in concentration of sodium hydroxide with sodium silicate solution in terms of molarity (M) makes the concrete more brittle with increased compressive strength. The cost of sodium hydroxide solid is high and preparation is very scathing. Therefore, to achieve desired degree of workability, extra water is required which ultimately reduce the concentration of sodium hydroxide solution. This solution is mixed and used after 24 hrs of mixing.

1.3 Water:

From the chemical reaction, it was observing that the water comes out from the mix during the polymerization process. The main purpose of water in the Geopolymer mix is to make workable in plastic state and do not contribute towards the strength in hardened state. Similarly, the demand of water increases with increase in fineness of material for same degree of workability. So, the minimum quantity of water required to achieve preferred workability is selected on the basis of degree of workability, fineness of fly ash and grading of aggregate.

1.4 Aggregates:

Aggregates are inactive mineral material used as filler in concrete which occupies 70–85 % volume. So, in the preparation of Geopolymer concrete, fine aggregates and coarse aggregates are mixed in such a way that it gives least voids in the concrete. This was done by grading of fine aggregate to total aggregate ratio. It is observed thet Workability of Geopolymer concrete is also affected by grading of aggregates.

1.5 Curing:

For the improvement of Geopolymer concrete, temperature and duration of heating plays an important role in the activation process. In the present investigation, cubes were demoulded after 24 hr of casting and then place in an oven for heating at 100 °C for a period of 24 hr. After 24 hrs of oven curing, oven is switched off and cubes are allowed to cool down to room temperature.

Then compression test is carried out on Geopolymer concrete cubes after a test period of 7 days and 28 days. The period of testing is considered in between testing cubes for compressive strength and placing it in normal room temperature after heating.

III. MIX DESIGN

The previous studies of Geopolymer concrete (M.I.Abdul and P.D.Arumairaj “Geopolymer Concrete A Review”) for different mix design we observed that the mix proportion (1: 1.5: 3.3) is most suitable mix proportion.

Table 2. Mix Design [6]

Materials	Kg/m3
Fly ash (Class F)	408.00
Fine sand	612.00
Coarse aggregate (20 mm in size)	1346.00
Sodium silicate solution	103.00
Sodium hydroxide solution (10 M)	41.00

For different molarity i.e. 10M, 12M, 14M the quantity of sodium hydroxide (NaOH) changes only.

IV. TEST RESULTS

Table 3. Compressive Strength of Geopolymer Concrete.

Molarity	Compressive Strength(N/mm^2)	
	7 Days	28 Days
Ordinary Block (0M)	14.22	18.16
10 M	15.11	18.66
12 M	21.77	23.11
14 M	24.22	25.11
16 M	21.33	21.77
18 M	17.56	18.22

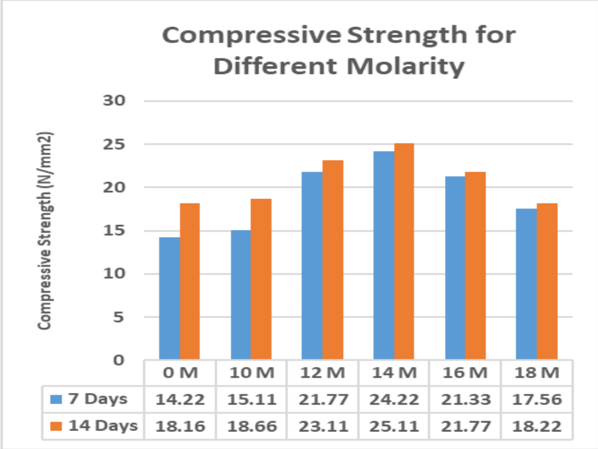

Fig 1. Graph: Compressive Strength of Geopolymer Concrete.

V. CONCLUSION

Based on this experimental work we are conclude that when the molarity of concrete increases at temperature 1000 C the compressive strength of Geopolymer concre te (M20) is increases at optimum doses of molarity. After that the strength get decreases.

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