Effect Of Concentration Of Sodium Hydroxide Solution On Geo-Polymer Concrete

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Abstract

Geopolymer is the new age concrete made by replacing cement in concrete by its substitute material which is pozzolanic in nature like metakaolin clay. This paper presents the effect of sodium hydroxide solution on workability of BFRGC.Mole's concentrations were used as alkaline activators. solution-to-fly ash ratio of 0.35 was considered in preparing geopolymermixes.The temperature of oven curing was maintained at 80°C each for a heating period of 24 hours and tested for compressive strength. Test results show that the workability and compressive strength both increase with increase in concentration of sodium hydroxide solution.

Keywords- *Metakaolin, geopolymer concrete, molarity, sodium hydroxide and sodium silicate*

1. Introduction

Cement which is main ingredient of concrete produces emission of green house gases like co2 [1,2]. As the demand is increasing in construction industry, consumption of cement is increasing. Source material such as metakaolin clay is present abundantly. Sodium hydroxide and sodium silicate solution were used as alkaline activators. Polymerization is the process of chemical reaction to form polymer chains. Metakaolin reacts with alkaline activators to form binder.

2. **literature Review**

P.Udaykumar et.al 2016 used metakaolin and granulated blast furnace slag (ggbs) to produce M40 geopolymer concrete. Beams were casted using geopolymer concrete and conventional concrete. They concluded that the load deflection curves were almost similar for both the beams. However the cracking moment was lower for geopolymer beam compared with conventional beam.

Sonali et. al 2014 found out that by increasing the quantity of quarry sand upto certain limit, the compressive strength increases. The quarry sand was used 60% in place of river sand. The cement was replaced with GGBS. They concluded that the workability increased by increasing the GGBS percentage but the strength was found to be decreasing.

Rashida et. al 2016 used fly ash in the geopolymerconcrete. The samples were cured at 60˚C and one ay curing time. The concentration of NaOH was taken from 4M to 18M to study the mechanical properties of geopolymer concrete. Hence the optimum concentration which exhibited satisfactory results was found out to be 12M where the best mechanical properties were obtained.

Peigang He et.al 2010 studied the effect of high temperature on nicrostructure and mechanical properties on unidirectional carbon fiber reinforced geopolymer composite. They found out that the mechanical properties can be improved by heat treatment in temperature from 1100 to 1300˚C. for composites which were treated at 1400˚C, their mechanical properties were lowered.

3. **Methodology**

3.1 Materials used

3.1.1 Metakaolin

Metakaolin is a De-hydroxylated form of the clay mineral kaolinite. The particle size of metakaolin is smaller than cement particles, but not as fine as silica fume. The quality and reactivity of metakaolin is strongly dependent of the characteristics of the raw material used. Metakaolinis produced by heating kaolin natural clay to temperature between 650-900°C .It has high performance high strength and resistance increase due to chemical attack and has increased durability.

Table 1.Physical properties of Metakaolin [3]

Specific gravity	2.40 to 2.60
Color	Off white
Physical form	Powder
Average plastic size	<2.5 µm
Brightness	80-82
Hunter L BET	15 m2/g
Specific surface	8-15 m2/g

Table 2.Chemical Composition of Metakaolin [3]

Chemical composition	Wt. %
Sulphur Trioxide (SO3)	<0.50
Alkalis (Na2O, K2O)	<0.50
Loss of ignition	<1.00
Moisture content	<1.00

Table 3. Metakaolin properties [3]

Physical Properties	Metakaolin
Specific gravity	2.5
Mean grain size	2.54
Specific area (cm2/g)	150000-18000

Color	Ivory to cream
Chemical Composition	
Silicon dioxide (SiO_2)	60-65
Aluminum oxide(Al_2o_3)	30-34
Iron oxide (Fe203)	1.00
Calcium oxide (CaO)	0.2-0.8
Magnesium oxide (MgO)	0.2-0.8
Sodium oxide (Na_2O_3)	0.5-1.2
Potassium oxide (K_2O)	
Loss on ignition	<1.4

3.1.2 Fine Aggregate

Fine graded aggregate was used to give minimum void ratio and free from deleterious materials like clay, silt content and chloride contamination etc. locally available river sand (coarse sand) conforming to Grading Zone II of IS 383:1970 was used as fine aggregate. The sand was washed and screened at site to remove deleterious materials and tested as per the procedure given in IS 2386:1968 (Part-3).River sand from Chandrapur is used in this study .

Table 4 . Physical Properties of fine aggregate

S.No	Property	Values
1	Specific gravity	2.63
2	Fineness modulus	2.51
3	Bulk modulus	1564

3.1.3 Sodium Hydroxide

Sodium hydroxide, also known as caustic soda, is an inorganic compound. The most common alkaline activator used is the mixture of Sodium hydroxide and sodium silicate. It is a white solid and highly caustic metallic base and alkali of sodium which is available in flakes, granules, and as prepared solutions at different concentrations. Due to its availability, it is used in various manufacturing industries such as paper industry etc.

Table 5.Specifications of Sodium Hydroxide Flakes [3]

MinimumAssay (Acidimetric)Maximum limits of impurities	96%
Carbonate	2%
Chloride	0.1%
Phosphate	0.001%
Silicate	0.02%

Sulphate	0.01%
Arsenic	0.0001%
Iron	0.005%
Lead	0.001%

3.1.4Sodium Silicate

Sodium silicate is the common name for Na_2SiO_3. Also known as water glass or liquid glass, which are available in aqueous solution and in solid form.

$$Na_2CO_3 + SiO_2 \rightarrow Na_2SiO_3 + CO_2$$

A chemical reaction occurs with the excess $Ca(OH)_2$(Portlandite) present in the concrete that permanently binds the silicates with the surface, making them far more durable and water repellent. This type of activator plays an important role in the polymerization process.

3.1.5 Coarse aggregate

Graded coarse aggregate of size 10mm was used in the study as per IS 383:1970.

Table 6 Physical properties of coarse aggregates

Specific gravity	2.79
Bulk density (kg/m3)	1511
Fineness modulus	7.3
Water absorption	0.41

3.2. **Methodology**

3.2.1 Preparation of alkaline solution

Sodium hydroxide pellets were used to prepare solution. The molecular weight of sodium hydroxide is 40. For example to prepare 8molar sodium hydroxide solution, 320gm of NaOH flakes were weighted and dissolved in distill water to prepare one litre solution.

3.2.2 Mixing of geopolymer concrete

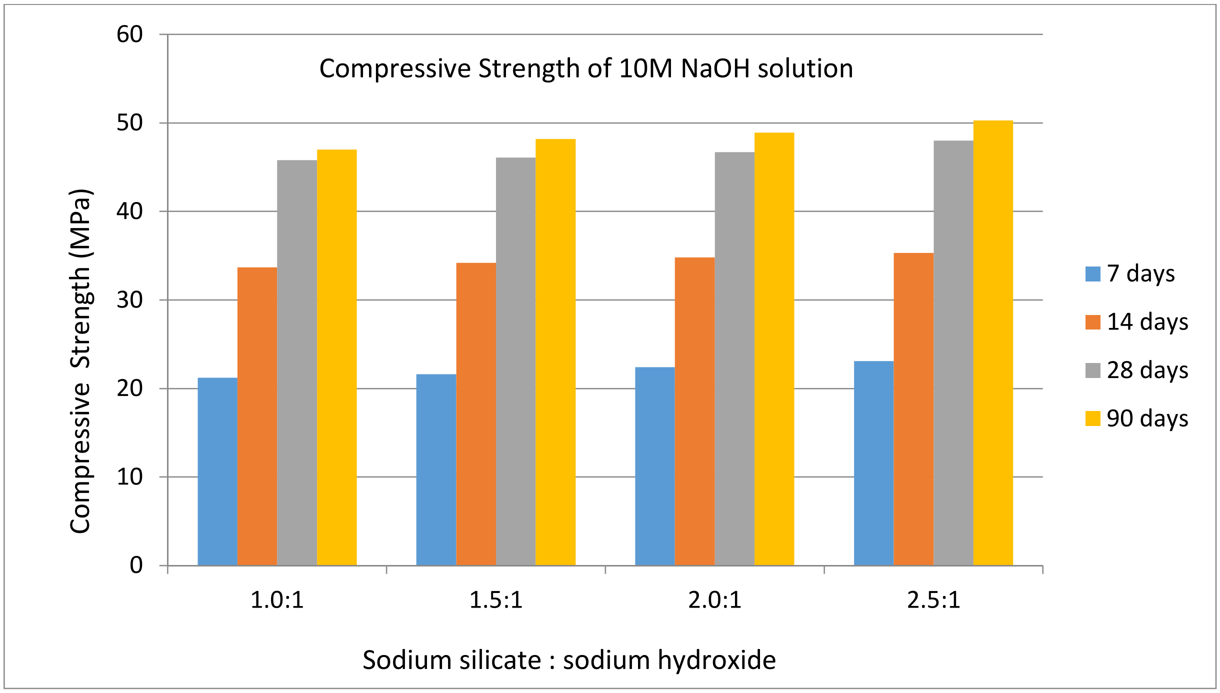
Metakaolin powder, fine aggregates and coarse aggregates were mixed properly till uniform colour was obtained. After thorough mixing, the alkaline solution which was prepared 24hours prior, was poured into the dry mix and mixed properly. The prepared concrete mix was poured into 150mm cubes and vibrated on shake table. As no code for mix design of geopolymer concrete is available , its density is assumed.

3.2.3 Curing

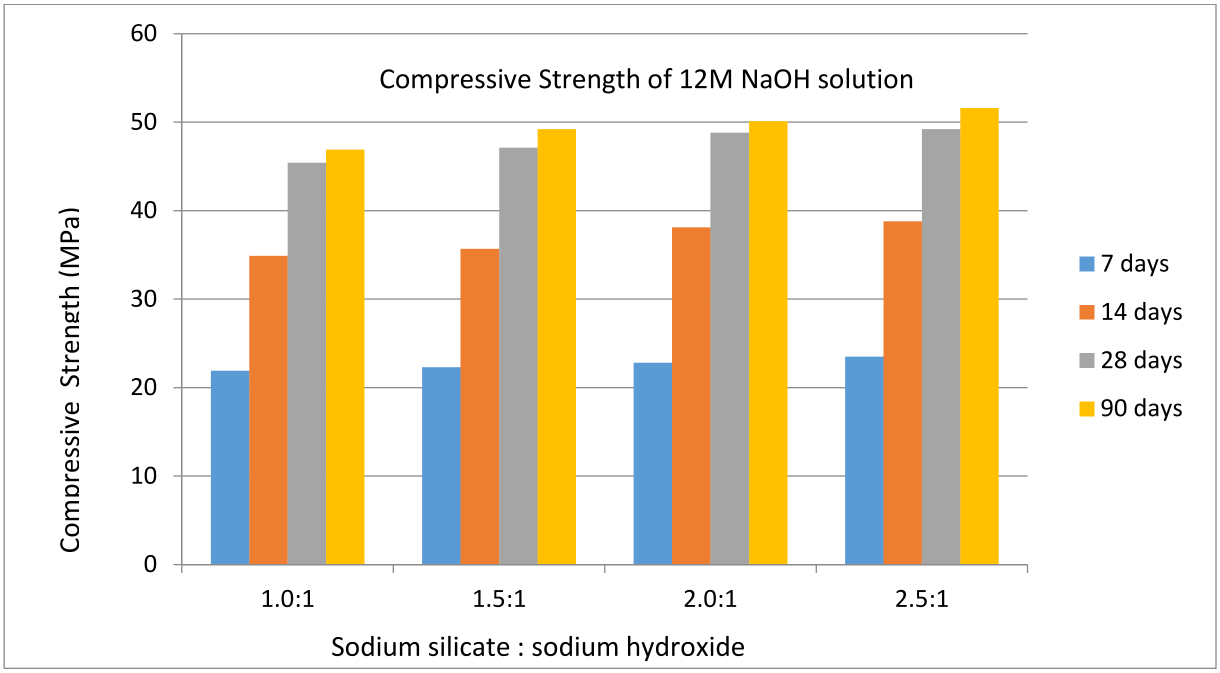
The geopolymer concrete moulds are oven cured at 80°C each for a heating period of 24 hours. Then the samples are ambient cured after demoulding and tested for compressive strengths.

4. Results

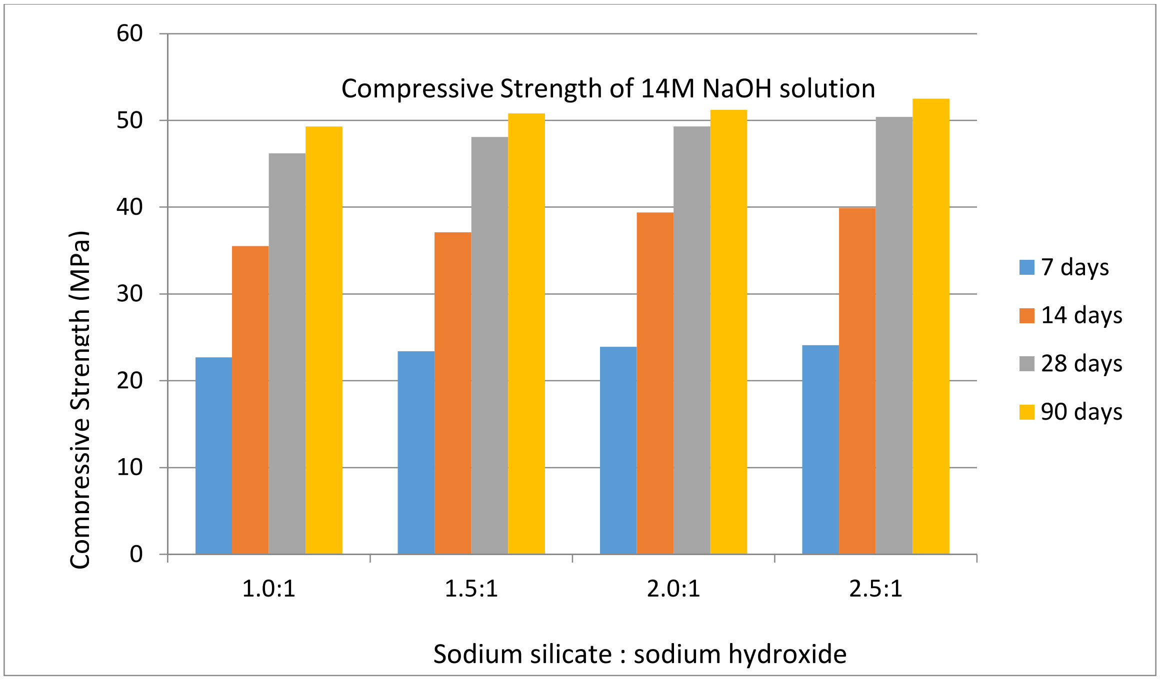
In this section, the experimental results obtained are presented.



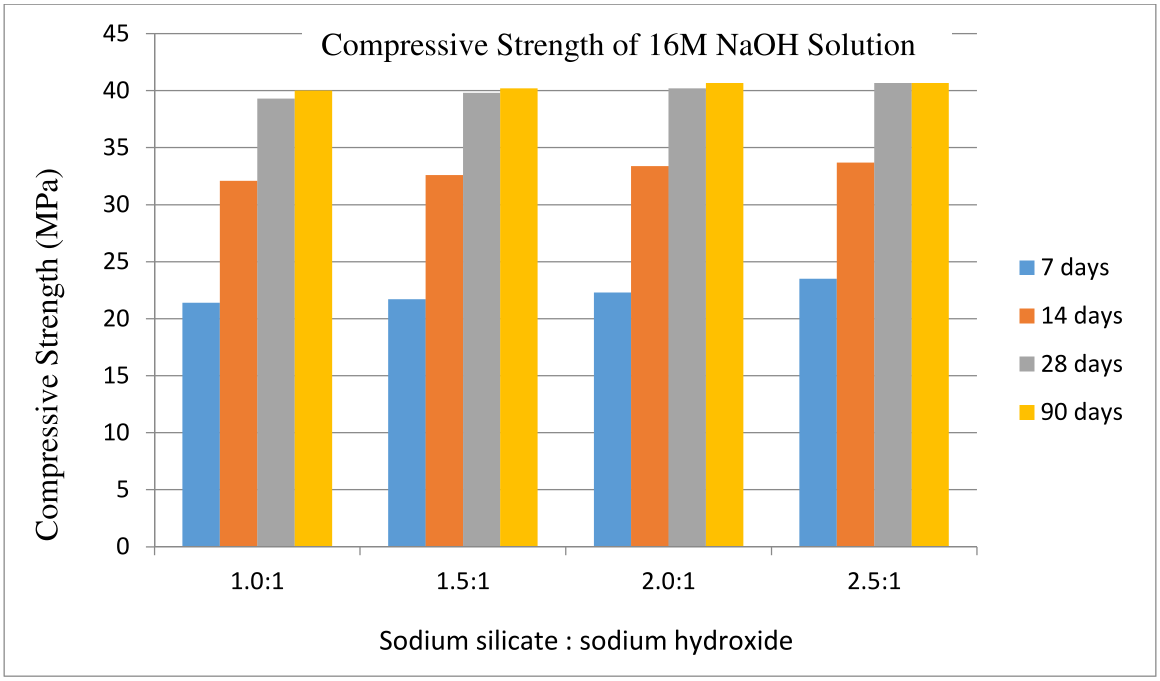
Graph 1: Compressive Strength of 10M NaOH Solution



Graph 2: Compressive Strength of 12M NaOH Solution



Graph 3 : Compressive Strength of 14M NaOH Solution



Graph 4 : Compressive Strength of 16M NaOH Solution

5. Conclusion

With the increase in molarity of sodium hydroxide solution, the compressive strength of geopolymer concrete strength was found to be increased upto 14 M after which is was found to be decreasing. Strength gain of geopolymer concrete increases with age upto 90 days after which there is no significant increase in strength. Ambient curing helped in attaining strength which is also practically convenient. Early compressive strength is observed in case of geopolymer concrete, hence where high early strength is required in projects, geopolymer concrete can be proved beneficial.

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