# Effect of NaOH solution concentration and curing time on the properties of Geopolymer concrete

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***Abstract*: Since last many decades researchers are working to find the alternative of conventional concrete. In the order geopolymer was introduced, which is the most alternative suitable of conventional concrete. With the use of Geopolymer based concrete, CO2 emission can be reduced by using the industrial waste. Previous work shows that it is the most suitable material for structural applications with comparable strength to Portland cement concrete. For further analyzing the compatibility of Geopolymer based concrete, here in this work effect of Sodium hydroxide ($NaOH$) solution concentration, curing time (days) and temperature was analyzed.**

***Keywords*: Geopolymer concrete, solution concentration, curing time, temperature**

## 1. Introduction

The term geopolymer had coined in France by the scientist named as Professor Davidovits around 1978. By assembling$OPC$, the cycle debilitates the resources and furthermore it's far an energy serious procedure that discharges huge quantity of $CO2\ gas$ into environment. Around 1 ton of crude $CO2\ gas$ delivered to assembling 1 ton of Ordinary Portland cement. It has now made as explicit guideline of blending pro long substance like fly residual into concrete for incompletely supplanting concrete. As of late, some cementitious materials produced by an aluminosilicate antecedent actuated in antacid fluid has been progressed and this issue was named as geopolymer [3]. Geopolymer has nowadays came as solitary designing fastener texture with manageable properties. Geopolymers are inorganic mixes with restricting limit that will work as the concretes. The geopolymer-gel network is developed from tetrahedral aluminosilicate frameworks adjusted by methods for soluble base cations - adjusted by antacid cations [4]. In first phase of geopolymerisation, the enacting mixes of receptive slurry will assault aluminosilicate strong compound, delivering monomers of aluminate & silicate in arrangement. These monomers & oligomers polycondense and structure cross linkage to form an $3-D$ alumina-silicate gel interface [5].

This work offers an itemized investigation of exploratory program on GPC beams (Geo-polymer strengthened solid shafts). Strengthened GPC beams were projected utilizing fine total, coarse total, fly debris, GGBS and OPC in different extents and the equivalent was tried. The example was read for its mechanical conduct. The particulars of test examples were determined dependent on the compressive and rigidity of cement. The diversion qualities, split examples, sorts of disappointment modes are portrayed.

## 2. Materials

Different materials selected in the experimental purpose are alkaline solution, fly ash, coarse aggregate, fine aggregate, superplasticizer, water, geopolymer mortar.

### 2.1 Alkaline solution

In geo-polymerization, soluble arrangement additionally assumes a significant job. The most well-known antacid arrangement utilized in geo-polymerisation is a mix of sodium hydroxide or potassium hydroxide and sodium silicate or potassium silicate. In the current examination, a blend of sodium hydroxide and sodium silicate was utilized as the soluble arrangement. The accessibility of sodium hydroxide solids is either as pellets or plates having a particular gravity 1.49 and its immaculateness of 98%. The substance organization of sodium silicate arrangement is Na2O=14.1%, SiO2=29.5%and water 56%by mass. Different attributes of sodium silicate arrangement are explicit gravity=1.49g/cc.

### 2.2 Fly ash

Geopolymer concrete is delivered by initiating alumino-silicate founded source quantifiable with an antacid arrangement. Fly debris, which is wealthy in silica and alumina, can possibly be utilized as one of the source materials for geopolymer fastener. Therefore, fly debris has been picked as a base material to incorporate geopolymer to all the more likely use this modern waste side-effect material. The synthetic structure of fly debris as dictated by X-Ray Fluorescence (XRF) examination is appeared in Table 1.

Table.1 Synthetic Configuration of Fly Ash as controlled by XRF.

| Different Oxide | Mass percentage |
|---|---|
| Aluminium oxide ($Al_2O_3$) | 31.5 |
| Ferric oxide ($Fe_2O_3$) | 5.46 |
| Silicon dioxide ($SiO_2$) | 50.35 |
| Total $SiO_2 + Al_2O_3 + Fe_2O_3$ | 87.31 |
| Phosphorus pentoxide ($P_2O_5$) | 1.8 |
| Sulphur trioxide ($SO_3$) | 1.6 |
| Calcium oxide (CaO) | 9.11 |
| Titanium dioxide ($TiO_2$) | 0.625 |
| Potassium oxide ($K_2O$) | 1.61 |

**2.3 Coarse and fine aggregates**

Coarse total is taken in a container, and they are absorbed water for around 24 hours. After culmination of 24 hours, it is exposed to immersed surface-dry (SSD) condition with garments. These coarse totals are acquired in a squashed structure, however most of particles are of stone kind. Here we are utilizing the size of the coarse total 25-20mm, 20-12.5mm, 12.5-10mm. The waterway sand acquired from nearby source was utilized as a fine total utilized for readiness. The particular gravity of sand is 2.66 and fineness modulus of sand is 2.65. As indicated by 383-1970, the sand is in Zone-III.

**2.4 Geopolymer mortar**

Geopolymers are set up by the blending just fly debris alongside soluble activator arrangement is called geopolymer glue. The blender is generally homogeneous slurry which dim green. Both geopolymer glue and mortar blend was durable in a new state. In arrangement of geopolymer blends, the accompanying scopes of incorporating boundaries are chosen and contemplated their impact on compressive strength of GPM.

**2.5 Molarity of sodium hydroxide (naoh)**

$NaOH$ Molarity: - $7M,\ 8M,\ 10M,\ 12M,\ 14M, 16M.$
Restoring time: going from one to three days
Curing temperature: - $350℃\ to\ 850℃.$

**3. Material selection and mixed proportion**

Different materials like fly ash, sand, $NaOH$ and $Na_2SiO_3$ solution, were collected in the require proportion. Soluble activator is the arrangement of $NaOH$ and $Na_2SiO_3$ arrangement. Sodium hydroxide arrangement arranged by taking the predefined weight of $NaOH$ pellets into a dish, pound it and add adequate measure of water as per its molarity. Sodium hydroxide is in pellets development with having 96% immaculateness, and sodium silicate with the compound creation of $Na_2O = 14.1\%, SiO_2 = 29.5\%$ and water 56% by mass was utilized in the current exploration. Take adequate measure of sodium hydroxide pellets in a bowl by estimating with a gauging machine and this pellet will move to the receptacle, which is as of now having the deliberate or adequate measure of water. At that point blend the $NaOH$ pellets in that water gradually response will begin and leave this answer for 1.5 days. Following 1.5 days of length measure the adequate measure of sodium silicate arrangement and blend $NaOH$ and $Na_2SiO_3$ arrangements. Locally accessible fine totals (sand) in immersed external dry state were utilized. The fly debris and fine totals are first to dry blend it in the prospect minutes at that point guarantee that combination is homogeneous. At that point blend the soluble arrangement, which is now arranged required focus scope of $7M\ to\ 20M$ and completely blended for at any rate 15 minutes. All blending cycle should be completed appropriate cooled at a room temperature of $275℃$.

**3.1 Block formation**

The readied Geopolymer glue (GPP) was moved into $80\ x\ 80\ x\ 80\ mm$ shape molds subsequent to blending in two covers as depicted in the ASTM C109 standard. By utilizing altering pole alter it each layer by 25 blows. All the projecting examples are vibrating on a vibrating table for at any rate 2 min. for the expulsion air voids.

Figure 1:- Cubic block form of geopolymer concrete.

**3.2 Curing**

After block settling promptly all the blocks are moved into the broiler for relieving at a raised temperature for at any rate 48 hours and indicated time. Following 24 hours drawn the moulds from stove and give 1 hour rest period after that eliminate shape and spot the examples into broiler further 1.5 day.

Figure 2:- Curing of modified GPC block.

## 4. Testing

After stove relieving, every one of these blocks are taken out from their 3D shape moulds, and these moulds restored undisturbed to room temperature until the testing time. The Geo-polymer mortar (GPM) blocks were tried for 3- and 7-day's compressive strength utilizing Compression Testing Machine.

### 4.1 Sodium hydroxide ($NaOH$) solution concentration

Blends were set up to examine the impact of Molarity (or) grouping of Sodium Hydroxide arrangement on the compressive strength of geo-polymer mortar. The convergence of $NaOH$ fluctuated from 7M to 20M. For all blends fly debris, sand, $Na_2SiO_3$ loads were kept consistent, and the proportion of fly debris to sand by weight for all blends is kept as 1:1.

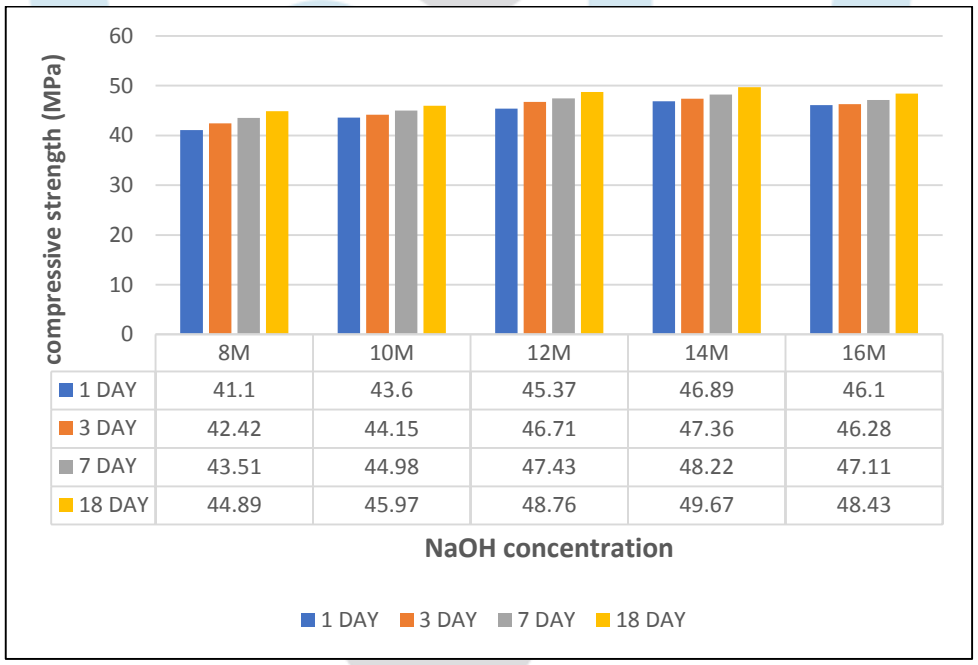


Figure 3:- Compressive Strength variation with different Concentrated $NaOH$.

### 4.2 Curing temperature

Blends were set up to contemplate the impact of restoring temperature on the compressive strength of Geo-polymer mortar. The wide range of various test factors were, for example, the convergence of $NaOH$, $Na_2SiO_3$ held consistent while the relieving temperature differed. This implies that the fly debris actuation was fragmented inside the presented relieving system (restoring at raised temperature 30℃ $to$ 90℃ for 4 days).

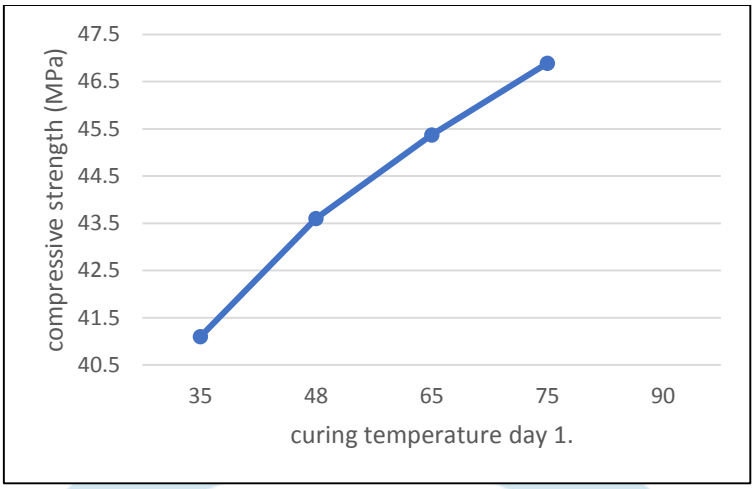


Figure 4:- For day 1 Compressive Strength vs Curing temperature.

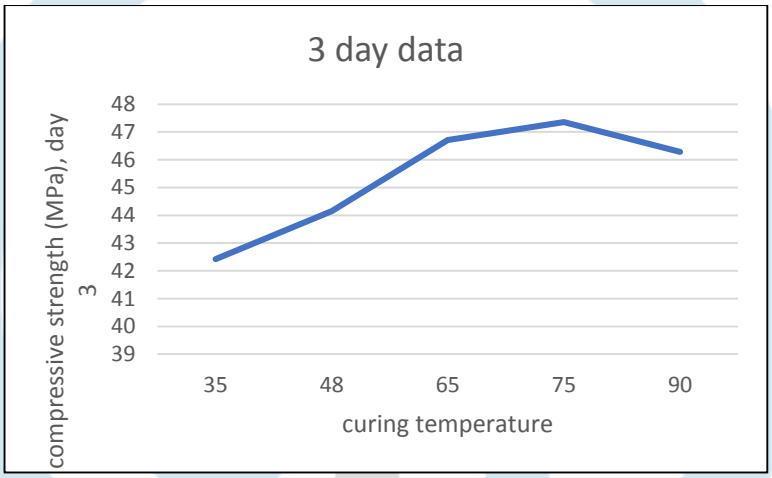


Figure 5:- For day 3 Compressive Strength vs Curing temperature.

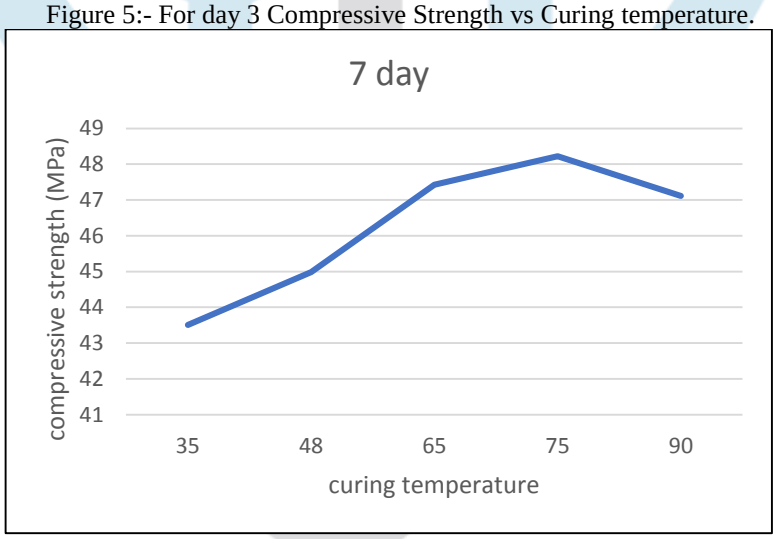


Figure 6:- For 7 day Compressive Strength vs Curing temperature

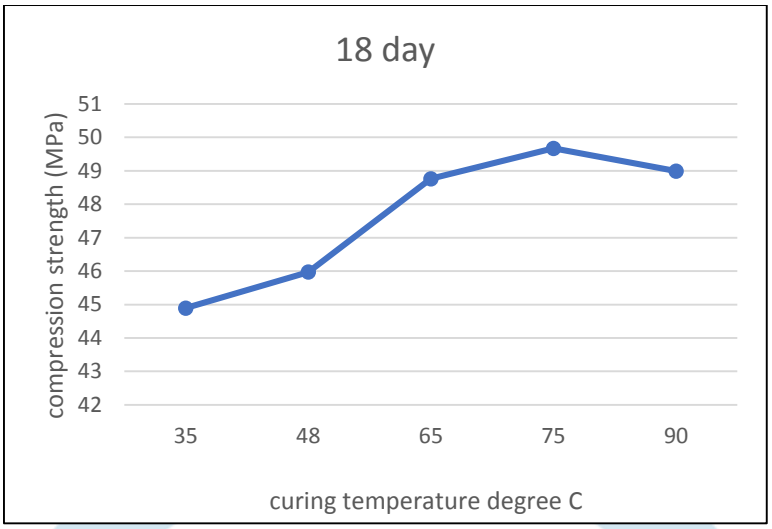


Figure 7:- For 18 day Compressive Strength vs Curing temperature.

## 5. Result and discussion

To examine the impact of sodium hydroxide fixation on the new properties just as on compressive strength of SCGC, four solid blends $8M, 10M, 12M, 14M, 16M$ were readied. The wide range of various test boundaries were kept consistent. The exploratory aftereffects of different new properties and compressive strength test are given in different Tables in above chapter 6 separately. Whole testing was done after the solidifications of blocks in different days and the readings were plotted in graph as given bellow.

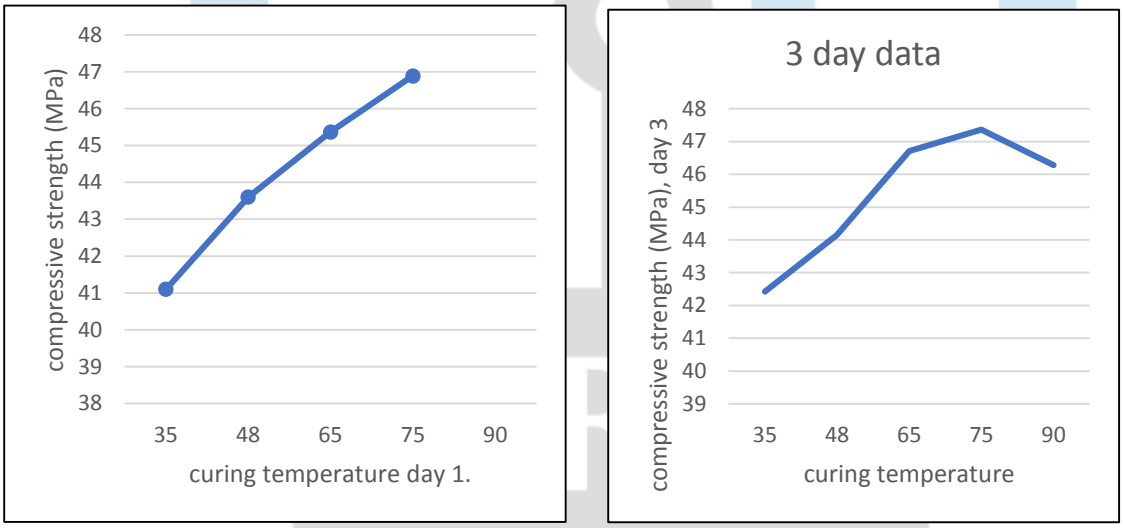


Figure 8:- For day 1 and 3 day Compressive Strength vs Curing temperature

**Conclusions**

Expanding the convergence of NaOH arrangement proportionately Increases the Strength of the Fly Ash-based Geo-polymer mortar. The temperature is expanding from 35℃ *to* 90℃ proportionately the strength of the Geo-polymer mortar is additionally expanding. Longer season of relieving, in the reach between one to four days then it produces higher compressive strength geopolymer mortar. Notwithstanding, the expansion in compressive strength past 3 days of time is not huge. The expansion of naphthalene sulphonate-based superplasticiser, up to around 8% of fly debris by mass, improves the usefulness of new geopolymer concrete; in any case, there is a slight corruption in the compressive strength of solidified solid when the superplasticiser measurement is higher than 5%. As the proportion of water-to-geopolymer solids by mass expands, at that point the strength of geopolymer solid declines. When contrasted with standard Portland concrete early strength improvement in geopolymer concrete is higher.

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[3] Ordinary Portland cement (**OPC**)

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