Change in the Compressive Strength of Geopolymer Concrete with the Change in the Curing Time and Curing Temperature

Shalika Sharma
M.E.Scholar, National Institute of Technical Teacher’s Training and Research, Chandigarh, India

Abstract—India is one of the developing countries that is facing the problem of environmental pollution. To reduce environmental pollution caused by the production of Portland cement, the use of alternate waste material was felt. Geopolymer concrete made by using flyash and alkaline liquid as a binder can be used to replace the Portland cement. Hence, an aluminosilicate polymer, Geopolymer was invented by Prof Davidovits. GPC also utilizes the abundantly available materials such as fly ash, rice husk, GGBS, WPS ashes and foundry sand that are waste by products & not easily disposed. Geopolymer concrete doesn’t use any cement, the production of cement shall be reduced and hence the pollution caused by further compaction on the vibrating table.

Keywords—abrasion resistance, curing time, curing temperature, global warming, geopolymer concrete, waste material.

I. INTRODUCTION

With the boom in infrastructure, the demand for concrete and cement is increasing day by day. The production of cement is increasing 3 % annually. The production of one ton of cement leads to emission of 1 ton of CO₂ into atmosphere. CO₂ contributes 65 % of global warming. With the increase in global warming the need for alternative material has been felt. The production of cement leads to CO₂ emissions which leads to global warming. Geopolymer invented by Joseph Davidovits is an inorganic aluminosilicate polymer obtained from silicon (Si) and aluminium (Al) materials of geological origin or byproduct materials like fly ash, metakaolin, Granulated Blast furnace slag etc. The chemical reaction takes place under alkaline condition on Si-Al minerals that result in polymerization. A three dimensional polymeric chain and ring structure consisting of Si-O-Al-O bond is formed. Geopolymers show many advantages. Low-calcium fly ash-based geopolymer concrete has excellent compressive strength, excellent resistance to sulfate attack and good acid resistance and has less drying shrinkage and low creep. It can be used in many infrastructure applications.

II. SCOPE AND OBJECTIVE OF WORK

The objective of the present study is to investigate the compressive strength of Geopolymer Concrete of M20 grade with the variation in curing time from 120 hours to 72 hours and also varying temperature for curing from 25°C, 60°C, 80°C. The ratio of flyash to alkaline liquid was 0.4 and the ratio of NaOH to Na₂SiO₃ is 2.0.

III. EXPERIMENT

The manufacturing of geopolymer concrete is similar to cement concrete. The process involves the preparation of alkaline solution, dry mixing, wet mixing, curing & testing of samples. To prepare sodium hydroxide solution of 12 molarity, 480 g (12 x 40) i.e. (molarity x molecular weight) of sodium hydroxide pellets were dissolved in one litre of distilled water. The prepared NaOH solution was added to sodium silicate solution, the ratio of NaOH/Na₂SiO₃ = 2 at least 24 hours before mixing. Then it was added to the mix of aggregates both coarse and fine and fly ash. The flyash was obtained from Ropar Thermal Power Plant. The coarse aggregate (size 20mm), fine aggregate, flyash were taken in the ratio 2:1:1 in a mixing tray and dry mixed manually for about two minutes. The addition of solution was done in small quantities so that there was no wastage of solution, usually the wet mixing time takes about 10 to 15 minutes. The mixing of total mass continued until the mixture became homogeneous and uniform in color. After this the mix was left for 10 to 15 minutes. The fresh geopolymer concrete was casted in cubes of size 100 X 100 X 100 mm to three layers and was compacted by using the standard compaction rod so that each layer receives 25 strokes followed by further compaction on the vibrating table. Then the cubes were kept in oven for curing. The casted specimens were kept in oven at 25°C for the curing period 120 hours and another specimens were kept in an oven for 60°C and 80°C for 72 hours. After the required curing period the specimens were removed from the oven and were kept open at room temperature until testing.
A. Compressive Strength

The specimens were removed from the oven; after the cooling of the samples, the specimens for the required period (7th day, 14th day and 28 days) were tested as per IS 516:1979 in the Compressive Testing Machine of capacity 2000 kN for obtaining ultimate load of the specimens. The compressive strength is one of the most important properties of concrete and is considered as the characteristic material value for the classification of concrete. A set of three cubes for each mix was tested after specified curing period. The average compressive strength of the three cubes for all mix composition was done. The results of tests at 7, 14 and 28 days were recorded for further analysis.

B. Effect Of Curing Time And Temperature

It was designed to study the effect of curing time and curing temperature on the geopolymer concrete. Two levels of curing time i.e., 72 hours for heat curing of 60°C and 80°C and curing time of 120 hours for curing temperature of 25°C was used for the purpose of research.

C. Effect Of Alkaline Solution

For the preparation of sample of geopolymer concrete the ratio of alkaline solution-to-Fly ash ratio was kept 0.4. Then the ratio of sodium hydroxide to sodium silicate was kept 2.

<table>
<thead>
<tr>
<th>TABLE I</th>
<th>CONSTITUENTS OF FLY ASH (DATA COLLECTED FROM XRF MACHINE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO2</td>
<td>P2O5</td>
</tr>
<tr>
<td>59.09 %</td>
<td>3.0 Kcps</td>
</tr>
<tr>
<td>Al2O3</td>
<td>MgO</td>
</tr>
<tr>
<td>299.8 Kcps</td>
<td>30.77 %</td>
</tr>
<tr>
<td>Fe2O3</td>
<td>Na2O</td>
</tr>
<tr>
<td>2.06 %</td>
<td>0.3 Kcps</td>
</tr>
<tr>
<td>CaO</td>
<td>0.07 %</td>
</tr>
<tr>
<td>TiO2</td>
<td>BaO</td>
</tr>
<tr>
<td>31.3 Kcps</td>
<td>1.65 %</td>
</tr>
<tr>
<td>K2O</td>
<td>ZrO2</td>
</tr>
<tr>
<td>21.0 Kcps</td>
<td>1.06 %</td>
</tr>
<tr>
<td>MnO</td>
<td>V2O5</td>
</tr>
<tr>
<td>3.7 Kcps</td>
<td>0.04 %</td>
</tr>
<tr>
<td>Re</td>
<td>0.05 %</td>
</tr>
<tr>
<td>3.5 Kcps</td>
<td>SrO</td>
</tr>
<tr>
<td>0.02 %</td>
<td>25.9 Kcps</td>
</tr>
<tr>
<td>0.02 %</td>
<td></td>
</tr>
</tbody>
</table>
IV. RESULTS

Tests were conducted. The specimens of 100 mmX 100 mm were tested for 7 days, 14 days and 28 days. The specimens which were cured at 25°C were heat cured at 120 hours while the rest were heat cured at 72 hours. The graph between compressive strength (N/mm$^2$) of geopolymer concrete and the number of days it took to achieve this strength is shown below.

V. CONCLUSION

It was found that the sample of geopolymer concrete having the ratio of fly ash to alkaline liquid as 0.4 and ratio of NaOH to Na$_2$SiO$_3$ as 2 cured at the temperature of 25°C required curing time of 120 hours but still the compressive strength was very less. The samples which were cured at 60°C and 80°C required lesser curing time of 72 hours and attained greater compressive strength.

REFERENCES


[8] Paras S.Pithadiya , Abhay V.Nakum “Experimental Study on Geopolymer Concrete by using GGBS” International Journal Research in Engineering and Technology e ISSN:2319-1163/p ISSN:2321-7308


[14] M.Adams Joe, A.Maria Rajesh, Roy Mammen “Study Of The Strength Geopolymer Concrete With Alkaline Solution Of Varying Molarity”. 