Comparative study on Strength characteristics of Geopolymer concrete with Altered Curing Conditions

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Abstract- Geopolymer is a material resulting from the reaction of a source material that is rich in silica and alumina with alkaline solution. The Geopolymer has been studied extensively over the past several decades and shows promise as a greener alternative to ordinary Portland cement concrete. It has been found that geopolymer has good engineering properties with a reduced carbon footprint resulting from the zero-cement content. This paper presents about characters of geopolymer concrete with different curing conditions and explains regarding various strength such as compressive strength, Split tensile strength performed on geopolmer concrete specimens with different curing conditions

Keywords- Geopolymer, Sodium hydroxide, sodium silicate, Compressive strength.

I. INTRODUCTION

Concrete is the world's most versatile, durable and reliable construction material. Next to water, concrete is the most used material, which requires large quantities of Portland cement. Ordinary Portland cement production stands second to the automobile as the major generator of carbon dioxide, which pollutes the atmosphere. In addition to that large amount energy is also consumed for the cement production. Hence, it is inevitable to find an alternative material to the existing most expensive, most resource consuming Portland cement. On the other hand, the abundant availability of fly ash worldwide creates opportunity to utilize this by-product of burning coal, as a substitute for OPC to manufacture concrete. In this work, low-calcium (ASTM Class F) fly ash-based Geopolymer is used as the binder, instead of Portland or other hydraulic cement paste, to produce concrete. The fly ash-based geopolymer paste binds the loose coarse aggregates, fine aggregates and other un-reacted materials together to form the geopolymer concrete.

II.GEOPOLYMERS.

Davidovits proposed that an alkaline liquid could be used to react with the silicon (Si) and the aluminum (Al) in a source material of geological origin or in by-product materials such as fly ash and rice-husk ash to produce binders. Because the chemical reaction that takes place in this case is a polymerization process, he coined the term geopolymer to represent these binders. Geopolymers are members of the family of inorganic polymers. The chemical composition of the geopolymer material is similar to natural zeolitic materials, but the microstructure is amorphous. 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 consisting of Si–O–Al–O bonds. Water is released during the chemical reaction that occurs during the formation of geopolymers

III.MATERIALS AND METHODS

A. Fine Aggregate

In this study, river sand has been used as fine aggregate.

B. Coarse Aggregate

The coarse aggregate used for study is obtained from a local crushing unit having 20mm nominal size. 20mm well-graded aggregate according to IS-383 is used in this investigation

C. Fly Ash

Fly ash is finely divided residue resulting from combustion of coal. In recent time, the importance and use of fly ash in concrete has grown so much that it has almost become a common ingredient in HSC & HPC and it is also highly utilised for manufacture of PPC. In this study fly ash conforming to class F obtained from Fly Ash Brick Company is used.

D. Alkaline liquid

Generally alkaline liquids are prepared by mixing of the sodium hydroxide solution and sodium silicate at the room temperature. When the solution mixed together the both solution start to react i.e. (polymerisation takes place) it liberate large amount of heat so it is recommended to leave it for about 24 hours thus the alkaline liquid is get ready as binding agent.

E. Sodium hydroxide

Sodium hydroxide with 98% purity, in flake or pellet form, is commercially available. The solids are dissolved in water to make a solution with the required concentration. For the study sodium hydroxide solution with 8 Molar is used.

F. Sodium silicate

The sodium silicate solution is commercially available in various grades. A solution with a Na2O/SiO2 ratio by mass of approximately 2 (say, Na2O = 14.7%, SiO2 = 29.4%, and water = 55.9%) is used.

Figure 1 (a) Geopolymer concrete cubes

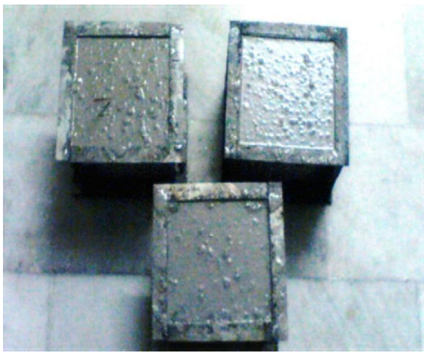


Figure 1 (b) Geopolymer concrete cylinders

IV.EXPERIMENTAL PROGRAMME

For this study Strength tests are carried on the controlled concrete, GPC cured at ambient temperature and GPC cured at 60 Deg for 24 Hrs. In order to study strength properties Compressive strength test is performed on cured concretes at age of specimen at 7^{th} day, 28^{th} day. And Split tensile strength is performed on cured concretes at age of specimen at 7^{th} day, 28^{th} day for both controlled concrete specimens and Geopolymer concrete specimens and concrete of grade M25 is used.

V.RESULT AND DISCUSSIONS

Strength studies

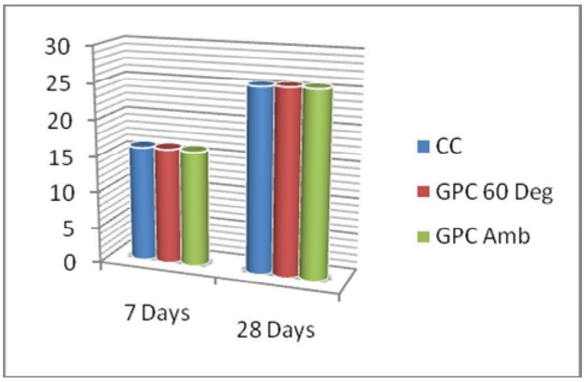
A. Compressive Strength

The compressive strength of concrete has determined by conducting tests on 150 x 150 x 150 mm cube specimens at age of 7 days and 28 days of curing. The test specimen are tested in the compression testing machine of 2000 KN capacity.

Table 1. Compressive strength

Specimen	Average compressive strength test at 7 Days	Average compressive strength test at 28 Days
Controlled concrete	**15.97**	**25.37**
G.P.C. 60deg 24Hrs	**16.02**	**25.53**
G.P.C Ambient	**15.97**	**25.55**

Figure 2 (a) Variations of compressive strength of concrete specimens



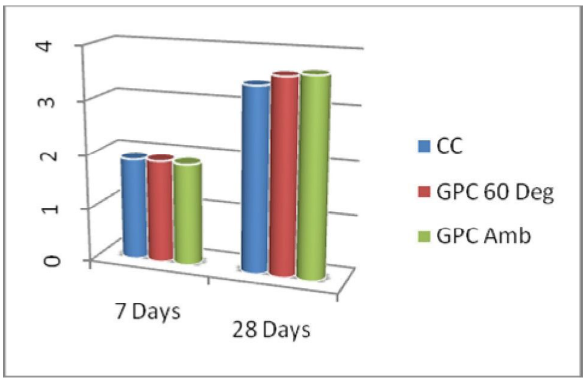
B. Split tensile strength

The test is carried out by placing a cylindrical specimen of 15 cm diameter, 30 cm long horizontally between the loading surfaces of a compression testing machine and the load is applied until failure of the cylinder along the vertical diameter.

Table 1b. Split Tensile strength

Specimen	Average compressive strength test at 7 Days	Average compressive strength test at 28 Days
Controlled concrete	1.9	3.4
G.P.C. 60deg 24Hrs	1.91	3.6
G.P.C Ambient	1.89	3.65

Figure 2 (b) Variations of split tensile strength of concrete specimens



VI.CONCLUSION

The results of the tests performed in this study indicate that a required Compressive strength can be achieved by G.P.C.cured at 60deg at initial ages and full strength can be achieved with ambient cured Geopolymer concrete at later ages and similarly that a required Split tensile strength can be achieved by G.P.C.cured at 60deg at initial ages and full strength can be achieved with ambient cured Geopolymer concrete at later ages and from studies it is revel that the geopolymer concrete can be an alternative to conventional concrete without any usage of cement which is needed by conventional concrete.

REFERENCES

[1] Anuradha, R., Sreevidya, V., Venkatasubramani, R. and Rangan, B.V. "Modified guidelines for geopolymer concrete mix design using Indian standard" *Asian Journal of Civil Engineering (Building and Housing) Vol. 13, No. 3, pp. 353-364, 2012.*

[2] Anurag Mishra, Deepika Choudhary, Namrata Jain and Manish, "Effect of concentration of alkaline liquid and curing time on strength and water absorption of geopolymer concrete", *ARPN Journal of Engineering and Applied Sciences,Vol. 3, No. 1, pp.14-18,2008.*

[3] Bakharev, T. "Geopolymeric materials prepared using Class F fly ash and elevated temperature curing", *Cement and Concrete Research,Vol.35, pp.1224-1232, 2006.*

[4] Davidovits, J. "Geopolymer chemistry and application"", *Geopolymers Institute, ISBN 2-651-4820-1-9, 2008.*

[5] Hardjito, D., Wallah, S.E., Sumajouw, D.M.J. and Rangan, B.V. "On the Development of Fly Ash –Based Geopolymer Concrete"" *ACI Materials Journal, Vol. 101, No. 1, 2004.*

[6] Malathi .V and Venkatasubramani (2012)" Strength study on Flyash based geopolymer concrete under heat curing" *International journal of emerging trends in Engineering and development Issue 2,Vol 4 pp113-120.*

[7] Vijaya Rangan Low-Calcium "Fly-Ash-Based Geopolymer Concrete" *Concrete Construction Engineering Handbook pp 26-20*