# Experimental Investigation on Geopolymer Concrete Under Different Modes of Curing

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***Abstract*— Various researches are going worldwide to find a replacement to Portland cement, as it produces carbon di oxide next to the automobiles which highly pollutes the atmosphere. In addition to that large amount of energy was also consumed for the cement production. Geopolymer concrete is one of the best replacement for this issue which is pollution free and it is constitutent of many residual materials which need space to be dumped as waste. The reaction of materials containing alumino silicates with concentrated alkaline solution to produce an inorganic polymer binder is known as geopolymer concrete. It is emerged as a possible solution for using the by-products of many industries which could be utilized in manufacturing of precast structure and non-structural elements, concrete pavements, concrete products and immobilization of the toxic waste that are resistant to heat and aggressive environment. Sodium hydroxide solution of 8 Molar concentration is mixed with sodium silicate gel is used as alkaline solution. The project is to test the beam column joints prepared by geopolymer concrete of various molarity of 8M. Curing of member is done by various methods mainly open air curing, heat curing and ambient curing with thin film wrapping in which thin film wrapped curing produces more results conclusive. So further projects can be carried out by film wrap up curing in geopolymer structural elements as heat curing in structural elements is uneconomical and practically impossible.**

***Keywords*— Geopolymer, Sodium Hydroxide, Sodium Silicate, Open Air Curing, Ambient Film Wrap up Curing.***

## INTRODUCTION

Need for concrete is the major issues that the world is facing in day to day life. Cement produces large amount $CO_2$ which contributes about 65% of global warming. The production of one ton of cement liberates about one ton of $CO_2$ to atmosphere. Although the use of Portland cement is unavoidable in the future, many researches are being made to find replacement to Portland cement in concrete. In this respect geopolymer concrete is very promising technique. They can be produced by reacting solid aluminosilicates with a highly concentrated aqueous alkali hydroxide or silicate solution. The chemistry and terminology of inorganic polymers was first discussed in detail by Davidovits. The present work is carried out in the framework of a project aims to produce the geopolymeric Mix procedure of different grade of geopolymer concrete matrices, stronger and denser equal to the cement concrete obtained by using Portland Cement binders, that can be used for the long term stabilization of inorganic toxic waste i.e. flyash. The particular work presented in this paper deals with a study investigating the Mix design and to examine the performances of various forms of fly ash-based geopolymer concrete under elevated temperatures.

## I. *MATERIALS USED*

Materials used in manufacturing of the fly ash-based geopolymer concrete are low calcium (class F) dry fly ash obtained from a local power station was used as the source material. For the alkaline activator, sodium hydroxide solution and sodium silicate solution was used. The sodium hydroxide solution was prepared by dissolving the sodium hydroxide solids of different variety such as pellets, flakes and tables in water. Extra water are also added to improve the workability of the fresh fly ash-based geopolymer concrete. Then, sodium silicate solution is added. All the liquids were mixed together before adding to the solids to make fresh concrete.

### *1.2 Sodium hydroxide*

Generally the cost of the sodium hydroxide is mainly varied according to the purity of the substance. Since our geopolymer concrete is homogenous material and its main process to activate the sodium silicate, so it is recommended to use the lowest cost i.e. up to 94% to 96% purity. In this investigation the sodium hydroxide pellets were used.

Fig -1 Sodium hydroxide

Fig -2 Sodium silicate

### *1.3 Sodium silicate*

Sodium silicate is available in liquid (gel) form. In present investigation sodium silicate 2.5 (ratio between NaOH to $Na_2SiO_3$) is used. As per the manufacture, silicates were supplied to the detergent company and textile industry as bonding agent. Same sodium silicate is used for the making of geopolymer concrete.

*1.4 Mix Design*

So far there is no proper standard mix design are available for GPC, since it is a new form of material in construction. So trial and error method is adopted. To arrive the mix proportion for the present study, the optimum values of different parameters were adopted from previous literature. The mix design for a Geopolymer concrete of $M_{30}$ grade is done by Indian standard (IS 10262-2009). Study on various trail mixes shows that this ratio provided near optimum strength and workability. Solid to liquid ratio posses a huge impact in compaction and strength factor.

## II. MIXING PROCEDURES

*2.1 Preparation of solution*

Sodium hydroxide is taken as per the rate various molar concentrations (8M) and dissolved in the water. It is recommended that the sodium hydroxide solution must be prepared 24 hours before the use as it produces large amount of heat energy and also it must not exceed 36 hours as it turns to semi solid liquid state. So the prepared solution should be used within this time. Both the solutions were mixed together at the time of casting only.

*2.2 Mixing of concrete*

Fly ash and aggregates (coarse and fine) are initially dry mixed in pan mixer for about 1min and alkaline solutions were added into pan and mixed for about 2 to 3 mins. Prepared molds are filled with fresh concrete in about three layer of equal heights and compaction is done by rod and vibrating table. Molds are further sealed to avoid moisture losses.

## I. MODE OF CURING

*3.1 Methods of curing*

Heat curing is important for the activation of fly ash along with the alkaline solutions, along with this open air curing and film wrap up curing is also adopted.

*3.2 Duration of open air curing*

In open air curing the specimen were kept for 28 days at in room temperature after specimen is removed from mould.

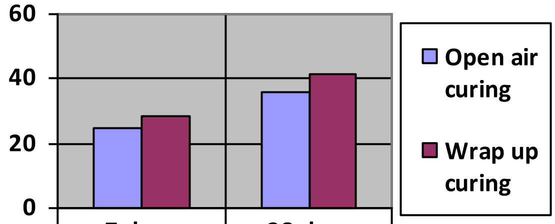
*3.3 Duration of wrap up curing*

In this method specimen are wrapped up with vinyl sheet and are kept at sunlight for 28 days.

## II. RESULTS AND DISCUSSIONS

*4.1 Compressive strength*

The compressive strength test was carried over 3 cubes from each set after 7 and 28 days of curing. The results of tests at 7 and 28 days are plotted as in Figure-1 respectively. Test shows that the wrap up curing shows significant results in both 7 and 28 days.

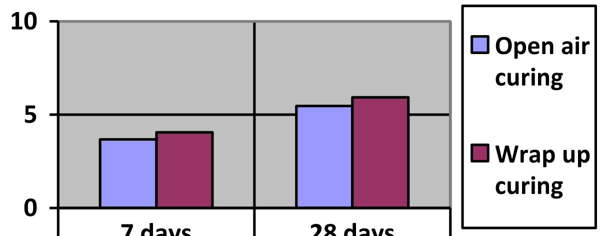



| | 7 days | 28 days |
|---|---|---|
| Open air curing | 24.83 | 35.73 |
| Wrap up curing | 28.67 | 41.53 |

Fig -3 Variations in compressive strength test result for 7 and 28 days of curing

*4.2 Split tensile strength*

The Split tensile strength test was carried over 3 cubes from each set after 7 and 28 days of curing. The results of tests at 7 and 28 days are plotted as in Figure-2 respectively. Test shows that the wrap up curing shows significant results in both 7 and 28 days.




| | 7 days | 28 days |
|---|---|---|
| Open air curing | 3.67 | 5.46 |
| Wrap up curing | 4.06 | 5.93 |

Fig -4 Variations in Split tensile strength test result for 7 and 28 days of curing

## III. CONCLUSION

The primary objective of this experiment is to examine open air curing and vinyl wrap up curing among which vinyl wrap up curing produces higher test result in both compression and spit tensile test. Test result increases about 10-14% in vinyl wrap up curing comparing open air curing as it is one of best and economical mode of curing.

REFERENCES

[1] P. Chindaprasirt, T. Chareerat, V. Sirivivatnanon, (2007), “Workability And Strength Of Coarse High Calcium Fly Ash Geopolymer”, ELSEVIER, vol. 29, pp. 224-229.

[2] R. Anuradha, V. Sreevidya, R. Venkatasubramani and B.V. Rangan, (2011), “Modified Guidelines For Geopolymer Concrete Mix Design Using Indian Standard” The Indian Concrete Journal, pp.353-364.

[3] Daniel L.Y. Kong, Jay G. Sanjayan,(2010),” Effect of elevated temperatures on geopolymer paste, mortar and concrete”, ELSEVIER, vol. 40, pp. 334-339.

[4] Anurag Mishra, Deepika Choudhary, Namrata Jain, Manish Kumar, Nidhi Sharda and Durga Dutt,(2008),” 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, pp. 14-18.

[5] Nisha Khamar, Resmi V Kumar,(2013),” Properties of Hybrid Fibre Reinforced Geopolymer Concrete under Ambient Curing”, International Journal of Science and Research, vol. 4, pp. 729-734.

[6] N.Ganesan, Ruby Abraham and S.Deepa Raj, (2015),”Experimental and Analytical Investigations on Geopolymer Concrete Columns Under Repeated Axial Compression”, Asian Journal of Civil Engineering, vol.16, pp. 651-662.

[7] Vijaya Rangan B, (2008),” Mix design and production of fly ash based geopolymer concrete” The Indian Concrete Journal, pp.7-14.

[8] IS 10262-2009 Recommended guidelines for concrete mix design.

[9] J. Davidovits, (1993) ,” Geopolymer cement to minimise carbon-dioxide greenhousewarming”,Ceramic Transactions, vol. 37, pp.165–182.

[10] J. Davidovits, (1991),”Geopolymers: inorganic polymeric new materials”, Journal of ThermalAnalysis, vol.37(8), pp.1633–1656.

[11] G.Maariappan, R.Singaravadivelan,(2013),”Studies on Behaviour of Rcc Beam-column Joint Retrofitted with Basalt Fiber Reinforced Polymer Shert”,Global Journal of Researches in Civil and Structural Engineering, vol.13.