

An Experimental Investigation of Geopolymer Concrete

Prof. S.G.Nikam¹, Vishal Kalbhor², Bhima Pujari³, Karishma Tambe⁴

Assistant Professor, Dept. of Civil Engineering, Shri Ramchandra College of Engineering. Lonikand, Pune, India.¹

BE Student, Dept. of Civil Engineering, Shri Ramchandra College of Engineering. Lonikand, Pune, India.²

BE Student, Dept. of Civil Engineering, Shri Ramchandra College of Engineering. Lonikand, Pune, India.³

BE Student, Dept. of Civil Engineering, Shri Ramchandra College of Engineering. Lonikand, Pune, India.⁴

ABSTRACT: Geopolymer concrete an innovative material that is characterized by long chains or networks of inorganic molecules is a potential alternative to conventional portland cement concrete for use in transportation infrastructure construction. It relies on minimally processed natural materials or industrial byproducts to significantly reduce its carbon footprint, while also being very resistant to many of the durability issues that can plague conventional concrete. However, the development of this material is still in its infancy, and a number of advancements are still needed. This Tech Brief briefly describes geopolymer concrete materials and explores some of their strengths, weaknesses, and potential applications.

The geopolymer concrete is such a vital and promising one. In this present study the main limitations of fly ash based geopolymer concrete are slow setting of concrete at ambient temperature and the necessity of heat curing are eliminated by addition of Ground Granulated Blast Furnace Slag (GGBS) powder which shows considerable gain in strength. The Alkaline liquids used in this study for the polymerization process are the solutions of sodium hydroxide (NaOH) and sodium silicate (Na₂SiO₃)

The cube specimens are taken of size 150 mm x 150 mm x 150 mm. Ambient curing of concrete at room temperature was adopted. In total 36 cubes were cast for different mix Id and the cube specimens are tested for their compressive strength at age of 1 day, 7 days and 28 days respectively. The result shows that geopolymer concrete cubes gains strength within 24 hours without water curing at ambient temperature. Also the strength of geopolymer concrete was increased with increase in percentage of GGBS in a mix. Thus the geopolymer concrete is considered to be an environmentally pollution free construction material.

KEYWORDS :- Geopolymer Concrete, curingless concrete, Waste material, Compressive Strength.

I. INTRODUCTION

The major problem that the world is facing today is the environmental pollution. In the construction industry mainly the production of ordinary Portland cement (OPC) will cause the emission of pollutants which results in environmental pollution. The emission of carbon dioxide during the production of ordinary Portland cement is tremendous because the production of one ton of Portland cement emits approximately one ton of CO₂ into the atmosphere. The geopolymer technology shows considerable promise for application in concrete industry as alternative binder to the Portland cement. In terms of global warming, the geopolymer concrete significantly reduce the CO₂ emission to the atmosphere caused by the cement industries Davidovits (1988; 1994) proposed that an alkaline liquid could be used to react with the Silicon (Si) and Aluminum (Al) in a source material of geological origin or in by product materials such as fly ash and GGBS 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.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

The geopolymer concrete has two limitations such as the delay in setting time and the necessity of heat curing to gain strength. These two limitations of geopolymer concrete mix was eliminated by replacing 10% of fly ash by OPC on mass basis with alkaline liquids resulted in Geopolymer Concrete Composite (GPCC mix). In other words, water is not involved in the chemical reaction and instead is expelled during curing and subsequent drying. This is in contrast to the hydration reactions that occur when Portland cement is mixed with water, which produce the primary hydration products calcium silicate hydrate and calcium hydroxide. This difference has a significant impact on the mechanical and chemical properties of the resulting geopolymer concrete, and also renders it more resistant to heat, water ingress, alkali–aggregate reactivity, and other types of chemical attack (Davidovits 2008; Lloyd and Rangan 2009). Conceptually, the formation of geopolymers is quite simple. In the case of geopolymers based on aluminosilicate, suitable source materials must be rich in amorphous forms of Si and Al, including those processed from natural mineral and clay deposits (e.g., kaolinite clays) or industrial byproducts (e.g., low calcium oxide ASTM C618 Class F fly ash or ground granulated blast furnace slag) or combinations thereof. In the case of geopolymers made from fly ash, the role of calcium in these systems is very important, because its presence can result in flash setting and therefore must be carefully controlled (Lloyd and Rangan 2009). The source material is mixed with an activating solution that provides the alkalinity (sodium hydroxide or potassium hydroxide are often used) needed to liberate the Si and Al and possibly with an additional source of silica (sodium silicate is most commonly used).

II. METHODOLOGY

The bureau of Indian standard recommended the procedure for design of concrete mix mainly based on the work done on national laboratories. The mix design procedures are covered in IS 10262-2009. The method given can be applied for both medium strength and high strength concrete.

1. General

In this work we study different properties of Geopolymer Concrete for achievement of objectives.

Following Material are used in Concrete:

- Sodium silicate.
- Sodium Hydroxide.
- Super plasticizer.
- Sodium naphthalene formaldehyde (SNF)
- Fly Ash.
- Ground granulated basalt slag (GGBS).
- Coarse aggregate.
- Fine aggregate.

The behavior of these types of material mentioned above in different environmental conditions, The Sodium silicate and sodium hydroxide in concrete a plays an important role to control the rate of Emission of carbon footprint and also to study the effect of Sodium silicate, Sodium Hydroxide, super plasticizer And SNF.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

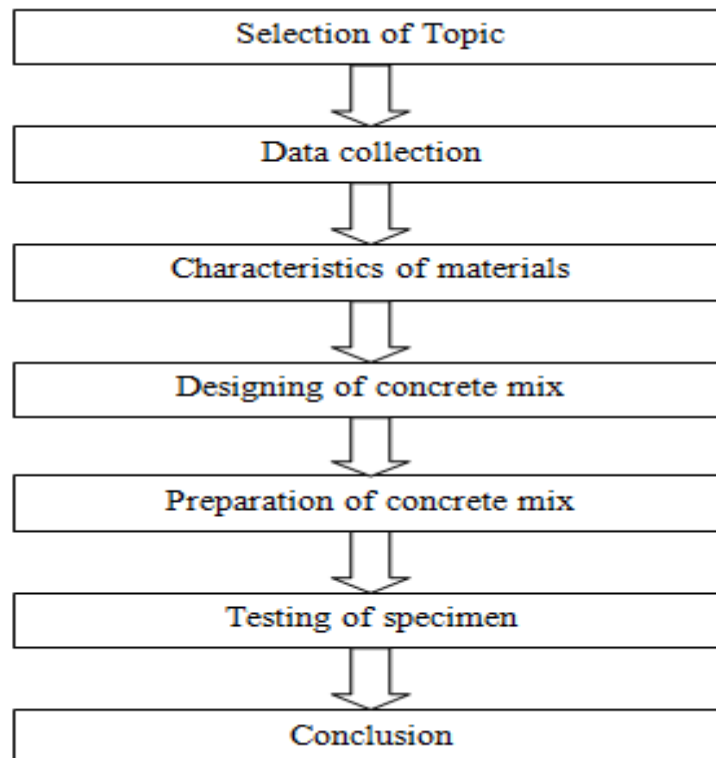


Fig.1 Flow Chart of Methodology

A. Casting Procedure: - (M30 DESIGN) IS IS 10262-2009)

1. The ingredients starting with coarse aggregate, fine aggregate and cement were weighed, and the dry mixture of the ingredients was firstly prepared.
2. Water was then added to the mixture thoroughly and continuous mixing was done and then all admixtures are also added. Mixing of concrete is done by hand mixing.
3. Mould prepared for specimen was placed on firm, hard and level surface. Before pouring of concrete in to mould its inner surface was prepared by coating it with crude oil.
4. The specimens were immediately casted after the mixing of concrete. The specimens were filled completely without any delay. The concrete was filled with 3 layers of 25 blows tamping with tamping rod for proper compaction.
5. After the concrete being placed its surface was prepared by leveling it. After the 24 hours from placing of concrete specimen mould was stripped and specimen was put into oven.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

4 Compression Test on cubes:-

SR. NO.	Date Of Casting	Variation of material	Testing Period	Strength In N/mm ²	Strength in %
1	13/03/2017	3% Admixture with 60° temperature.	Day 1	19.18	63.33
2	13/03/2017	3% Admixture Heated at room temperature.	Day 1	5	16.67
3	13/03/2017	5% Admixture with 60° temperature.	Day 1	18.74	62.71
4	13/03/2017	5% Admixture Heated at room temperature.	Day 1	3	10
3	14/03/2017	3% Admixture with 70° temperature.	Day 1	24.43	81.43
4	14/03/2017	5% Admixture with 70° temperature.	Day 1	20.22	67.40
5	11/03/2017	3% Admixture.	Day 7	28.49	94.96
6	11/03/2017	5% Admixture.	Day 7	15	50
7	11/03/2017	3% Admixture.	Day 28	32.7	109
8	11/03/2017	5% admixture.	Day 28	22.5	75

Table No 4.5 Compression Test on cubes

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

5 Chart's:-

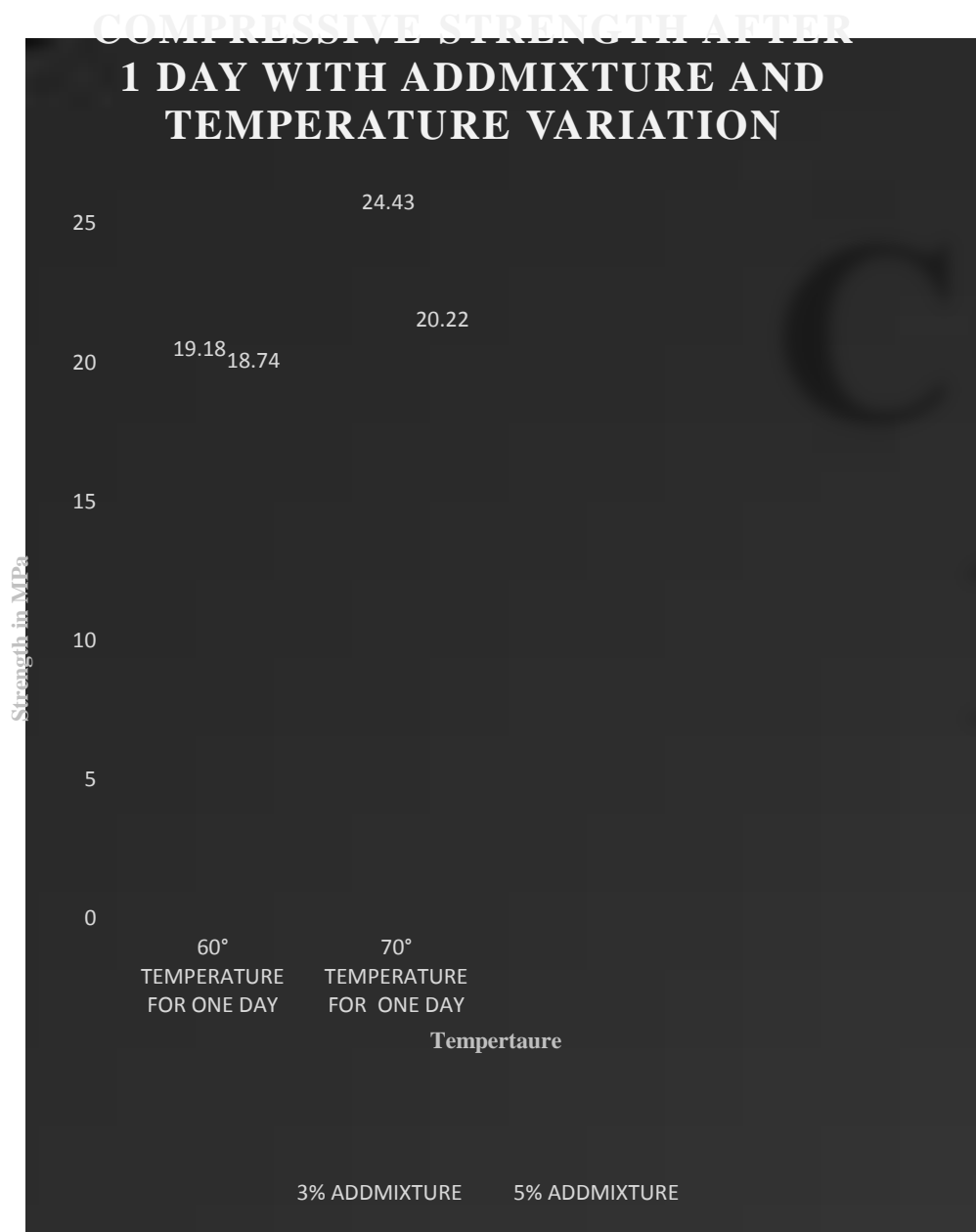


Fig. 5 Graphical represation of strength for 1 day.

International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

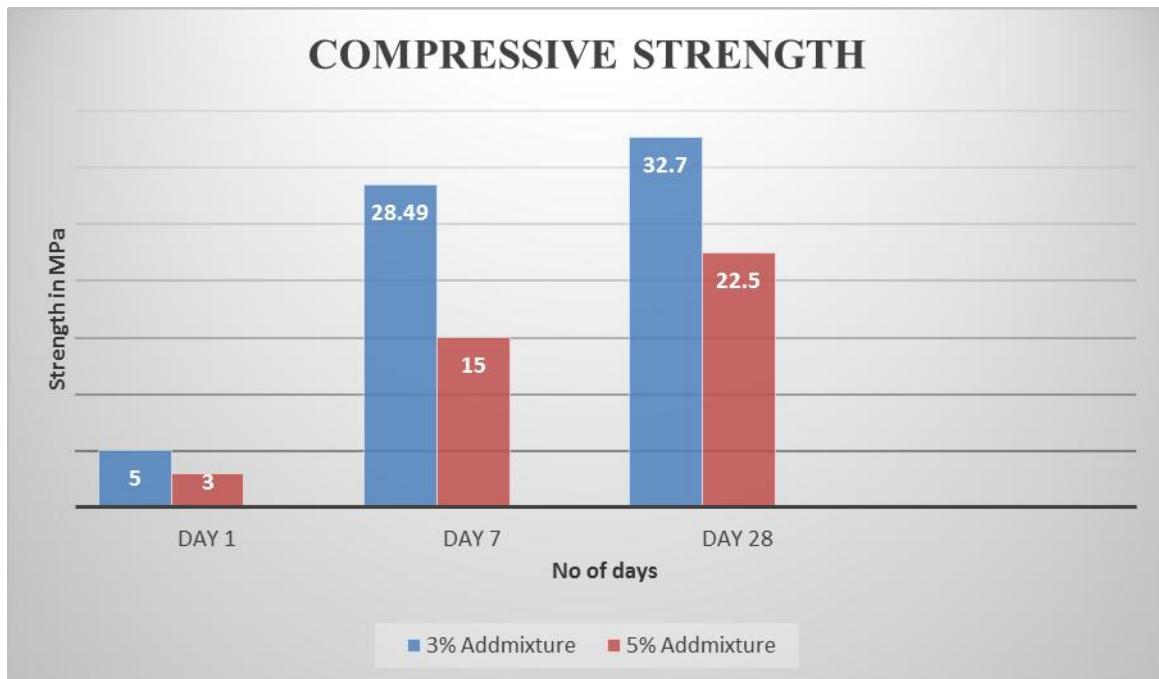
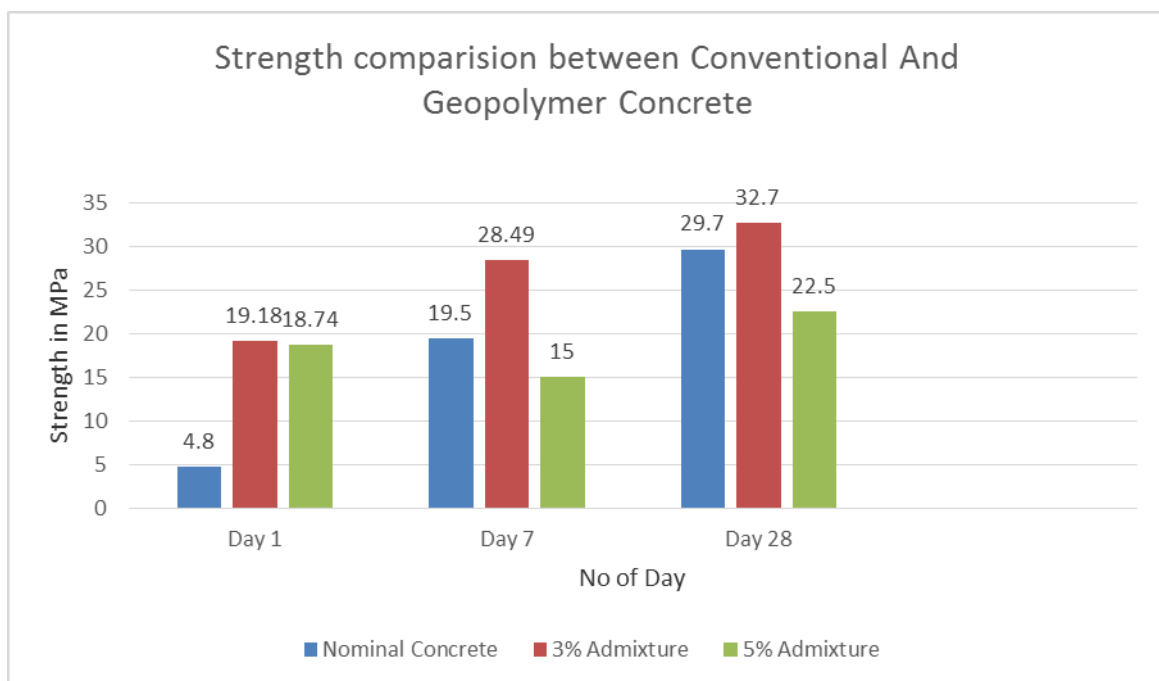


Fig.6 Graphical representation of strength after 1,7and 28 days.



International Journal of Innovative Research in Science, Engineering and Technology

(An ISO 3297: 2007 Certified Organization)

Website: www.ijirset.com

Vol. 6, Issue 5, May 2017

VII. CONCLUSION

- Geopolymer concrete is suitable for any R.C.C. structure.
- Strength is more as compare to conventional concrete.
- By using Sodium silicate and Sodium hydroxide it helps to minimize carbon footprint.
- If the temperature is increased then strength of concrete also increased.
- If there is increase in percentage admixture then it will cause to loss the strength generally maintain only 2 to 3%.
- Geopolymer concrete is more economical than conventional concrete
- Curing is not required as we are adding admixture such as Sodium silicate And Sodium hydroxide.
- Curing is not required as we are adding admixture such as Sodium silicate And Sodium hydroxide.
- Useful in the areas where shortage of water.
- It helps to prevent the corrosion of steel.

VIII. FUTURE SCOPE

- In future we are studied other alternative options for admixtures or agents.
- To find out alternative waste material source carried out optimization proportion.
- To control the setting time to heat curing.

REFERENCES

1. Ahmad B. "Effects of Alkaline Solution on Properties of the HCFA Geopolymer Mortars". (4th International Conference on Process Engineering and Advanced Materials, 2016).
2. Antonella Petrillo and Raffaele Cioffia. "Eco-sustainable Geopolymer concrete blocks production process" (The 5th International Conference of Euro Asia Civil Engineering Forum, 2015).
3. Arun Kumar Chakraborty "Effect of nano materials in geopolymer concrete" (Elsevier 2016).
4. C.M. Ruzaidi and Y.M. Liewa "Effect of Curing Profile on Kaolin-based Geopolymers" (ICPST 2011).
5. Eric P. Koehler and David W. Fowler. "Summary Of Concrete Workability Test Methods" (International Center for Aggregates Research The University of Texas at Austin, 2003). fiber sheets strengthened concrete cylinders using geopolymer as adhesive" (Elsevier 2016).
6. Hai-yan Zhang "Experimental study on high temperature properties of carbon
7. Joseph Davidovits "Geopolymer Chemistry and Applications 4th edition" (IRJET, 2013).
8. M.S. SHETTY "Concrete technology theory and practice".
9. Nitendra Palankar and A.U. Ravi Shankar "Studies on eco-friendly concrete incorporating industrial waste as aggregates" (IRJET, May 2015).
10. P. Vignesh and K. Vivek "experimental investigations on strength parameters of fly ash based geopolymer concrete with GGBS" (IRJET, May 2015).
11. Partha Sarathi "Drying shrinkage of slag blended fly ash geopolymer concrete cured at room temperature" (ICPST 2011).
12. Robina Kouser Tabassum and Ankush Khadwal. "A Brief Review on Geopolymer Concrete" (IJRET, 2015).
13. Tejas Ostwal et al. "Experimental investigations on strength, durability, sustainability & economic characteristics of geo-polymer concrete blocks" (IJEST, Feb 2012).
14. Thangaraj Sathanandam, Paul O. Awoyera et al. "Low carbon building: Experimental insight on the use of fly ash and glass fibre for making geopolymer concrete" (IRJET, March 2017).