International Journal of Research in Engineering, Science and Management
Volume-1, Issue-10, October-2018
www.ijresm.com | ISSN (Online): 2581-5782

Behaviour of Geopolymer Concrete in Construction Industry: A Review

K. Kunal[1], C. Piyush[2], M. Jitendra[3], S. Sachin[4]
[1,2,3]*B. Tech. Student, Department of Civil Engineering, Aravali Institute of Technical Studies, Udaipur, India*
[4]*Associate Professor, Department of Civil Engineering, Aravali Institute of Technical Studies, Udaipur, India*

***Abstract*—Geopolymer concrete is one of new technology of concrete which is used in today's scenario in field of construction industry. This concrete is an innovative construction material which can be produced by the chemical action of inorganic molecules of silicate and aluminate with alkaline solution. We use geopolymer concrete because it has advantages of rapid strength gain, elimination of water curing, good properties of mechanical and durability. These are eco-friendly sustainable material in place of OPC/PPC. Concrete is one of much more world's versatile, durable as well as reliable construction materials. After use of water, concrete is the very most used material, which required large quantities of Portland cement. In addition to that huge amount energy was also consumed for the cement production and also creates the emission of CO_2 that causes huge of environmental pollution. Hence, it is necessary to find an alternative material to the existing most expensive, most resource consuming Portland cement. Fly-ash is alternative material of concrete, which is by-product of coal obtained from the thermal power plant is plenty available worldwide. Fly-ash is rich in silica and alumina reacted with alkaline solution that produced aluminosilicate gel that acted as the good binding material for the concrete. Geopolymer concrete can be made without using any amount of ordinary Portland cement/ PPC. This paper just briefly reviews the constituents of geopolymer concrete, its gain mechanical and durability propertiesas well as potential applications of it.**

***Index Terms*—geopolymer concrete, fly ash, curing, applications**

I. Introduction

Geopolymer word was found by French professor Davidovit's in 1978 to represent a broad range of materials characterized by network of inorganic molecules [1]-[3].

Concrete is one of the most widely used construction materials, and it is usually associated Portland cement as the main component for making concrete.

On the other hand, the global warming is caused by the emission of greenhouse gases, like as CO_2 to the atmosphere.

The production of Portland cement worldwide is increasing 9% annually. The current contribution of greenhouse gas emission from Portland cement production is about 1.5 billion tonnes annually or about 7.0% of the total greenhouse gas emissions to the earth's atmosphere. Geopolymer concrete is a 'new' material that does not need the presence of Portland cement as a binder, instead, the source of materials such as fly ash (FA) and ground granulated blast furnace slag (GGBS), that are rich in silicon (Si) and aluminium (Al), are activated by alkaline liquids solution to produce the geopolymer binder [4].

In this respect, the geopolymer technology proposed which shows reduction in CO_2 in atmosphere approximately 80 to 82%. Geopolymer an alkaline liquid use to react with silicon aluminium as by product material to produce binder. Fly Ash having aqueous solution containing Sodium Hydroxide and Sodium Silicate in their mass ratio, results in a material with three dimensional polymeric chains.

II. Guidelines For Manuscript Preparation

In geopolymer concrete mix design, coarse and fine aggregates together were taken as 7% of entire mixture by mass. This value is quite similar to that used in OPC concrete in which it will be in the range of 75 to 80% of the entire mixture by mass. Fine aggregate was taken as approximately 30% of the total aggregates. The density of geopolymer concrete is taken similar to OPC as 2400 kg/m^3 [5].

Fig. 1. Material used in geopolymer concrete

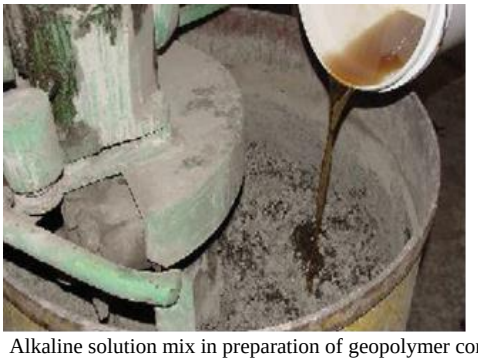
Fig. 2. Alkaline solution mix in preparation of geopolymer concrete

A. *Necessity of Geopolymer Concrete as Following*

Durability aspect of geopolymer product have good sustainability in various weathering action even though they are not good in place where temperature change occurs very frequently.it can sustain temperature of not more than 300-350c.

It is frequently used in today scenario because of it resistance property to the sulfuric and chloric effect on concrete structure.
The following are the constituents of Geopolymer concrete
Fly ash – it is by-product of thermal power plant
GGBS– it is by-product of steel plant
For normal concrete fine aggregate and course aggregate is used.
Alkaline activator solution for GPC, alkaline activator is the catalytic liquid system.

B. *Mechanical Property of Geopolymer Concrete*

Drying shrinkage of geopolymer concrete is much less than that of normal concrete.

This property makes it more suited for the work of thin and heavily restrained structure member.

As compare to normal concrete it has high heat of hydration.

Geopolymer concrete has good quality of fire resistance as compared to the normal concrete.

III. Geopolymer at Elevated Temperature

Fire resistance of concrete was other properties that are always considered due to the safety of user. They said that the ratio of fly ash to alkaline solution effect the general gain strength and fire resistance of geopolymer concrete [6]. This was found that the fly ash-based geopolymer concrete displayed increase in strength after temperature exposure.

These observed the behaviour of geopolymer concrete under elevated temperature affected by the size of aggregates. The aggregate with smaller size which is less than 10 mm could lead to spalling and cracking of geopolymer [7]. The larger aggregate (>10 mm) were more stable. In addition, the thermal incompatibility between the geopolymer matrix and its aggregate components was the most likely cause of strength loss in geopolymer concrete specimens at higher temperatures. This can be proved by comparison between geopolymer concretes made of two different aggregates with distinctly different thermal expansion characteristics. The geopolymer concrete with greater incompatibility led to higher strength loss during higher temperature. That's why the expansion of aggregate with respect to temperature was a factor that controls the performance of geopolymer [8].

IV. Applications

As we know that it is a good alternate for cement and hence it has same application as of cement.

Various application is given below.

- It can be used for construction of pavement
- It used in retaining wall
- It used in water tank
- It used in precast bridge deck
- It is nothing but for storey building for public use.

V. Results and Discussion

Reviewer study was found that Fly-ash reacted with alkaline solution and formed a binding material [1]. These observed that higher concentration of sodium hydroxide result in higher compressive strength and higher the ratio of sodium silicate-to-sodium hydroxide liquid ratio by mass, showed higher compressive strength of geopolymer concrete [9]. They also absorb that the increased in curing temperature in the range of 30 - 90 °C increased the compressive strength of geopolymer concrete and longer curing time also increased the compressive strength. They handled the geopolymer concrete up to 2 hours without any sign of setting and without any degradation in the compressive strength, resulted very little drying shrinkage and low creep also. These report that the Geopolymer mortar specimens manufactured from fly ash with alkaline activators were structurally permanent and did not show any recognizable change in colour after a little bit more than 4months exposure in 10% sulfuric acid solution and the Geopolymer Concrete was high resistance against sulfuric acid [10]. These are also revealed that the concentration (in term of molarity) of NaOH influenced the strength characteristic of geopolymer concrete [11]. Those are absorb that the Compressive strength of GPC increased over controlled concrete by approx. 1.5 times (M-25 achieves M-45), Split Tensile Strength of GPC increased over controlled concrete by 1.45 times and Flexural Strength of GPC increased over controlled concrete by 1.6 times [12].

These are also recommended that the cast in-situ application in Geopolymer concrete is a viable one [13]. This has successfully used Geopolymer Concrete in waste stabilize. Geopolymer Concrete immobilized chemical toxins and reduced level concentrations [14].

A. *Related Works to Geopolymer Concrete*

Since there is demand for natural sand, the fine aggregate shall be replaced partially by quarry dust in today era. Quarry dust has having high content of Silica, caused increase the compressive strength of Geopolymer Concrete by partial replacement of quarry dust. Different concentrations of Sodium Hydroxide solution NaOH (8M, 10M, 12M, 14M & 16M etc.) shall be used and the characteristics shall be studied. Similarly the different curing methods shall also be studied such as Hot air curing, Steam curing, Sun curing and ambient curing etc shall be studied for the above mentioned different Molar ratios of Sodium Hydroxide solutions. In order to study the use of Geopolymer Concrete like normal concrete, different structural elements like Plain Cement Concrete Beam, Reinforced Cement Concrete Beam, Reinforced Concrete Columns, Reinforced Beam Column joints shall be cast for the above discussed concentrations of NaOH solution and curing conditions and tested. The characteristics of geopolymer

concrete shall be studied and based on the test results use of Geopolymer Concrete in shall be minimize.

VI. Conclusion

From above paragraph it is very clear that due to it good physical as well as chemical property it is good alternate in place of simple concrete we use geopolymer concrete to make our structure more safer side.

It caused strain hardening in geopolymer concrete due to glass fibre and its properties also improve. This Geopolymer concrete is also economical benefits for our construction industry.

References

[1] Davidovits, J., "Pyramids of Egypt Man-Made Stone, Myth or Fact?" symposium on Archaeometry 1984. Smithsonian Institution, Washington DC, 1984.
[2] Davidovits, J., "Geopolymer Chemistry and its Applications" Institute Géopolymèr, Saint-Quentin, France. 2008.
[3] Geopolymer Institute, "What is a Geopolymer? Introduction Institute Géopolymèr", Saint Quentin, France. 2010.
[4] Madheswaran C. K, Gnanasundar G, Gopalakrishnan N, "Effect of Molarity In Geopolymer Concrete" Internation Journal of Civil and Structural Engineering, Vol. 4 No. 2, pp 106-115, 2013.
[5] Rangan, B. V., "Mix Design and production of Fly Ash-Based Geopolymer Concrete", The Indian Concrete Journal, 82, pp 7-14, 2008.
[6] Kong DLY, Sanjayan JG, "Damage behavior of geopolymer composites exposed to elevated temperature. Cement Concrete Composite". 30, pp 986-991, 2008.
[7] Kong DLY, Sanjayan JG, "Effect of elevated temperatures geopolymer paste, mortar and concrete. Cement Concrete Res., 40, pp 334-339, 2010.
[8] Lloyd, N., and V. Rangan, "Geopolymer Concrete—Sustainable Cementless Concrete." ACI Special Publication SP-261, 10th ACI International Conference on Recent Advances in Concrete Technology and Sustainability Issues. ACI, Farmington Hills, MI. 2009.
[9] Hardjito, D., S. Wallah, D. M. J. Sumajouw, and B. V. Rangan, "On the Development of Fly Ash– Based on Geopolymer Concrete." ACI Materials Journal, vol. 101, no. 6, pp 467-472, 2004.
[10] Suresh Thokchom, Partha Ghosh, "Resistance of Fly Ash Based Geopolymer Mortar in Sulfuric Acid"-ARPN journal engg and applied science, Vol. 4 No. 1, 2009.
[11] Anuar K.A, Ridzuan A.R.M., Ismail S., "Strength Characteristic of Geopolymer Concrete", International Journal of Civil & Environmental Engineering, Vol. 11 No: 01 pp 81-85. 2011.
[12] Raijiwala D.B.1 Patil H., "Geopolymer Concrete- a Concrete of next decade", Journal of Engineering Research and Studies, Vol. 2 No. 1, pp 19-25. 2011.
[13] Muhd Fadhil Nuruddin, Andri Kusbian toro, Sobia Qazi, Nasir Shafiq., "Compressive Strength and Interfacial Transition Zone Characteristic of Geopolymer Concrete with Different Cast In-Situ Curing Conditions", World Academy of Science, Engineering and Technology, Vol. 5 No. 1 pp 51-54, 2011.
[14] Douglas C. Comrie, John H. Paterson & Douglas J. Ritcey, "Applications of geopolymer technology to waste stabilization" D. Code Consulting Ltd, Boulevard East, Mississauga, Ontario. pp 161-165.