A Review on Geopolymer Concrete

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ABSTRACT
Concrete is the world’s most versatile, durable and reliable construction material. Next to water, concrete is the most used material, which required large quantities of Portland cement. Ordinary Portland cement production is the second only to the automobile as the major generator of carbon dioxide, which polluted the atmosphere. In addition to that large amount energy was 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. Geopolymer concrete is an innovative construction material which shall be produced by the chemical action of inorganic molecules. Fly Ash, a by-product of coal obtained from the thermal power plant is plenty available worldwide. Flyash is rich in silica and alumina reacted with alkaline solution produced aluminosilicate gel that acted as the binding material for the concrete. It is an excellent alternative construction material to the existing plain cement concrete. Geopolymer concrete shall be produced without using any amount of ordinary Portland cement. This paper briefly reviews the constituents of geopolymer concrete, its strength and potential applications.

Keywords--- Geopolymer Concrete, Fly Ash, Strength, Curing, Applications

I. INTRODUCTION
The name geopolymer was formed by a French Professor Davidovits in 1978 to represent a broad range of materials characterized by networks of inorganic molecules (Geopolymer Institute 2010), 2 & 3. The geopolymers depend on thermally activated natural materials like Meta kaolinite or industrial byproducts like fly ash or slag to provide a source of silicon (Si) and aluminum (Al). These Silicon and Aluminium is dissolved in an alkaline activating solution and subsequently polymerizes into molecular chains and become the binder. Professor B. Vijaya Rangan (2008), Curtin University, Australia, stated that, “the polymerization process involves a substantially fast chemical reaction under alkaline conditions on silicon-aluminum minerals that results in a three-dimensional polymeric chain and ring structure” 4 The ultimate structure of the geopolymer depends largely on the ratio of Si to Al (Si:Al), with the materials most often considered for use in transportation infrastructure typically having an Si:Al between 2 and 3.5 5 & 6. The reaction of Fly Ash with an aqueous solution containing Sodium Hydroxide and Sodium Silicate in their mass ratio, results in a material with three dimensional polymeric chain and ring structure consisting of Si-O-Al-O bonds7.

II. APPLICATIONS
In the short term, there is large potential for geopolymer concrete applications for bridges, such as precast structural elements and decks as well as structural retrofits using geopolymer-fiber composites. Geopolymer technology is most advanced in precast applications due to the relative ease in handling sensitive materials (e.g., high-alkali activating solutions) and the need for a controlled high-temperature curing environment required for many current geopolymer. Other potential near-term applications are precast pavers & slabs for paving, bricks and precast pipes.

III. LIMITATIONS
The followings are the limitations
Bringing the base material fly ash to the required location. High cost for the alkaline solution. Safety risk associated with the high alkalinity of the activating solution. Practical difficulties in applying Steam curing / high temperature curing process Considerable research is ongoing to develop geopolymer systems that address these technical hurdles.

IV. LITERATURE REVIEW
Abhishek Bisarya et al., [1] analyzed that the most research worked gave higher the strength lesser the
workability and vice versa. Hence there is need of the day to investigate the remedies of the problem of workability in Geopolymer Concrete.

Ammar Motorwala et al., [2] proved that increased in the compressive strength with increased in the molarity was seen.

Anuwar K.A et al., [3] inspect that the higher concentration of sodium hydroxide (NaOH) solution increased the higher compressive strength of geopolymer concrete will produced and also the higher concentration of NaOH will made the good bonding between aggregate and paste of the concrete.

Bapugouda Patil et al., [4] analyzed that M30 strength can be achieved without curing. Addition of GGPS gave good compression strength for the concrete. In HCl test changes are occurred. For saturated water absorption test at 28 days is about 10.90% less than the normal concrete. Fire resistance test it with stand up to 300°C and 600°C for both water and air cooling.

Bennet Jose Mathew et al., [5] determined that the curing at elevated and ambient temperature will form fly ash-GGBS based concrete of comparable strengths. Geopolymer concrete can be prepared at comparable cost with OPC based concrete provided transportation system for raw materials is well established.

Bharat Bhushan Jindal et al., [6] recommended that the Geopolymer concrete show high early compressive strength on heat curing which made it suitable for useful in pre casting industry and the compressive strength at 7 days equivalent or higher than the ordinary Portland cement in 28 days.

Bondar.D et al., [7] indicated that the strength of geopolymer concrete decreased as the ratio of water to geopolymer solids by mass increased.

Douglas et al., [8] successfully used Geopolymer Concrete in waste stabilization. Geopolymer Concrete immobilized chemical toxins and reduced leachate level concentrations.

IRobina Kouser Tabassum [9] said that the reduced CO2 emissions of Geopolymer cements built them a good alternative to Ordinary Portland Cement. Geopolymer concrete had excellent properties within both acid and salt environments.

Jaydeep S et al., [10] examined that the compared to hot air oven curing and curing by direct sun light, oven cured specimens gave the higher compressive strength but sun light curing is convenient for practical conditions. He also said that the compression strength is increased by increasing of molarities of sodium hydroxide.

Krishnan.L et al., [11] proved that the strength of geopolymer concrete was increased with increase in percentage of GGBS in a mixture.

Kumaravel.S [12] recommended that the fly ash based concrete gave better result that the normal concrete and it can be used in structural applications.

Mohd Mustafa Al Bakri et al., [13] investigate that the fly ash-based geopolymer was better than normal concrete in compressive strength, exposure to aggressive environment, workability and exposure to high temperature.

Monique Tohoué Tognonvi et al., [14] analyzed that the tubes of Geopolymer reinforced with sand show good resistance when they are subjected to acid, neutral or humid environment. The mechanical properties of those materials are not changed after durability tests. The presence of soluble species on the surface which would be hydroxide or carbonate potassium due to the increase of the pH value is found using SEM observation. The presence of potassium ions in the solution evidenced par ICP-AES analysis. The surface of samples appears not to be attacked which shows the stability of these materials.

Monu Malviya et al., [15] said that OPC Concrete had suffered more deterioration in acidic as well as sulphate solution as compare to Geopolymer Concrete Ammar Motorwala thus Geopolymer Concrete is more durable than OPC Concrete.

Prof.More Pratap Kishanrao [16] said that the mixture of fly ash and ground granulated blast furnace slag in equal proportions is used as binding material in complete replacement of conventional Portland cement to prepare geopolymer concrete mixes.

Muhd Fadhil Nuruddin et al.,[17] recommended that cast in-situ application in Geopolymer concrete is a viable one.

Neetu Singh et al., [18] proved that Fly ash based Geopolymer concrete has excellent compressive strength and is suitable for structural applications. Fly ash based Geopolymer concrete had no surface deterioration, formation of pores on the surface and spalling of concrete after immersion in aggressive solution for 30,60 and 90 days of exposure. The weight of the specimen is loosened. Fly ash based Geopolymer concrete had good resistance in sulphate attack. There are no changes the compressive strength of test specimens after an exposure period of 90 days. Heat cured Geopolymer concrete has an excellent resistance to chloride attack. Geopolymer concrete can be used in sea water area.

Raijivala et al., [19] noticed that the Compressive strength of GPC increased over controlled concrete by 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.

Shankar H. Sanni et al., [20] proved that the compressive strength loss for the specimens exposed in sulphuric acid were in the range of 10 to 40% in normal concrete and it was about 7 to 23% in Geopolymer. The Geopolymer concrete and normal mixes indicated minor changes in weight and strength when the specimens were exposed to sulphuric acid and magnesium sulphate.
Sourav Kr. Das et al., [21] recommended that the geopolymer concrete is a whole new concept of structural concrete with a new technology and detailed study on the chemistry behind the polymerization is needed.

Tejas Ostwal et al., [22] said that the strength achieved by Geopolymer blocks is 4MPa which is equal to the strength of cement concrete block of compression 23kN/m3. The average water absorption percentage of GPC block is found to be 1.40%. The cost of one block is estimated to be 50.62. Even though the costs of GPC blocks are higher as compared to traditional cement concrete block, it is recommended to use in place of cement concrete blocks and burnt brick, since GPC blocks are ecofriendly in nature.

Usha.S [23] said that the silica and alumina mixer are good binding agent when it’s mixed with fly ash and GGPS.

Vignesh.P et al., [24] inspect that the Water absorption property is lesser than the nominal concrete and achieved strength in a short time.

Vaidya.S et al.,[25] examined that uniform temperature was developed throughout the mass and Elastic Modulus and Poission’s ratio were within the acceptable limits.

V. CONCLUSION

Geo-polymer was widely used in structural work, road construction, aero-space materials, transportation, metallurgy mining etc. Strength and durability of the concrete can be obtained using Geo-polymer. In chemical industries waste materials like sodium hydroxide and sodium silicates are collected by the government to reuse as Geo-polymer material. So it reduced the cost of construction materials and helps to recycle chemical wastes. Better compressive strength can be obtained by ambient curing at 1200°C. Beyond 1200°C means it will reduce the strength of concrete. The major disadvantage of ambient cured reduced the weight of concrete and it losses the early strength of the concrete. So sunlight is used in tropical countries for curing. Geo polymer concrete should be cured under sunlight for 90 days to get better stability. But there will be no loss in the weight of concrete. The water content using in concrete is very low due to fly ash in the concrete. Therefore the super-plasticizers were mainly used to get better workability in concrete.

REFERENCE


