

A Review Paper on Strength Development of SCMS Based Geopolymer Cement

M. Anil Kumar¹, Mr. K. Naga Rajesh²

¹PG Student, ²Assistant Professor

^{1,2}Department of Civil Engineering, GMRI, Rajam, Andhra Pradesh, India

How to cite this paper: M. Anil Kumar | Mr. K. Naga Rajesh "A Review Paper on Strength Development of SCMS Based Geopolymer Cement" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-5, August 2019, pp.2379-2381, <https://doi.org/10.31142/ijtsrd27963>



IJTSRD27963

Copyright © 2019 by author(s) and International Journal of Trend in Scientific Research and Development Journal. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0) (<http://creativecommons.org/licenses/by/4.0>)



ABSTRACT

Ten to 50 % of the world's total carbon dioxide emissions come from producing cement. The global warming gas is discharged once stone and clays are crushed and heated to high temperatures. New age concrete is outlined as a concrete that uses the waste product as a minimum of one among its parts, or its production method doesn't cause environmental destruction, or it's high performance and life cycle property. Varied efforts are conducted by researchers to make some alternatives that can considerably cut back high energy consumed and environmental impacts throughout the fabrication method of cement, together with implementing the idea of commercial ecology. The cleaner technologies in concrete production, like work comparatively high proportion of cement by fly ash (up to 100%), the utilization of different natural pozzolans, development of concrete with usage or waste materials, and developing of new-age concrete by using polymerization of concrete the present reviews about performance of geopolymer concrete with the SCM materials Fly ash and GGBS

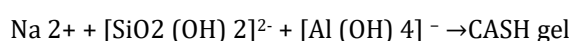
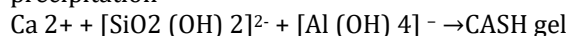
KEYWORDS: Geopolymer mortar, opc, SCMs, Activator, Bond strength, Compressive strength, Durability

I. INTRODUCTION

Ordinary Portland cement (OPC) has been historically used as a binding material for the preparation of concrete. However, the production of OPC contains a large environmental impact because of a large quantity of greenhouse emission released into the atmosphere ((Hardjito, Wallah, Sumajouw, & Rangan, 2004).

To decrease these negative effects on the atmosphere, new binding materials known as geopolymers for application in construction is preferred (Oss and Padovani 2002, 2003). To overcome these issues, geopolymer concrete (GPC) has been introduced that may fully eliminate cement with by-products and water with an alkaline solution. Which are synthesized from amorphous alumino-silicate-rich reactant bulk materials. Two primary waste materials are usually used, including GGBS and fly ash. The ensuing binder from the alkaline activation of the latter is noted as geopolymer. Alkali-activated systems have been generally classified into two classes based on the Chemical composition of precursor reactant bulk: Ca-Si and Al-Si Systems (Li et al. 2010). Fly ash is wealthy in alumina, silica and possesses pozzolanic properties which will react with alkaline activators to form aluminosilicate hydrate. The strength of the fly ash-based GPC is because of aluminosilicate hydrate, which forms because of polymeric chain method, whereas, in case of GGBS-based geopolymer concrete, the strength gain is due to the formation of the calcium salt hydrate gel. Ease of Use.

High calcium geopolymers (fly ash class c and GGBFS) the reactions during setting and hardening involving precipitation



It is reported that at high pH less than 12 CASH gel is stable and becomes feasible at a relatively low pH range of 9 to 12. NASH gel formed at later stages of reaction is responsible for strength development and is even stable at low pH (9 to 12) and it is also reported that initial formation of CASH or CSH gel responsible for early setting. The blending system has been reported to exhibit superior mechanical and durability performance in resisting sodium Na and (Mg) magnesium sulfate attack compared with normal Portland cement concrete. (Saavedra et al. 2016). 4% of slag is blended with fly ash-based geopolymer mortar concrete acquiring the strengths up to 70 Mpa (Li and Liu 2007). Partial replacement of fly ash with slag accelerates hardening, increases the achievable strength and reduces workability (Deb et al. 2014). The loss of workability is attributed to the presence of free lime (creating the C-S-H gel) And coarse and angular structure of slag particles Effectively, incorporation of slag eliminates the requirement for heat curing needed by fly ash-based geopolymers, therefore reducing the consumption of energy and emission of CO₂.

II. LITERATURE REVIEW

1. Ankur Mehta et al (2018) have carried a study on Sustainable Geopolymer Concrete using Ground Granulated Blast Furnace Slag and Rice Husk Ash. The fractured pieces of 90 day compressive strength test specimens for GPC mixtures with 10, 15 & 20% RHA were subjected to SEM, EDS & XRD analysis for

microstructure properties. The maximum compressive strength of approximately 69MPa is achieved with 85% GGBS and 15% RHA at 90 days. Based on the results obtained, the optimum content of RHA, as partial replacement of GGBS can be reported as 15%.

2. **JianheXie et al (2018)** Have carried a study on Effects of combined usage of GGBS and fly ash on workability and mechanical properties. The SEM observations will be used to verify the reaction of fly ash in all mixes. The combination of GGBS and fly ash can provide excellent synergetic effects on workability and mechanical performance for the Geopolymer concrete with recycled coarse aggregates.

3. **Zhen Chen et al (2018)** Have experimented on the Compressive strength and micro structural properties of dry-mixed Geopolymer pastes synthesized from GGBS and sewage sludge ash. The drying shrinkage of all the geopolymer pastes increased rapidly in the first 7 days. Thereafter, the drying shrinkage only increased gently and further increase was very small after 28 days. Too high or too low Na₂O content and modulus had detrimental effects on the compressive strength. The highest compressive strength was 32.8 Mpa at 28 days with the pastes prepared with the optimal Na₂O content of 4.0% and modulus of 0.95.

Drying shrinkage tests indicated that using activators with lower Na₂O contents and activator moduli can reduce the drying shrinkage of the dry-mixed geopolymer pastes cured at room temperature.

4. **A. Karthik et al (2017)** Have experimented on Investigation on mechanical properties of fly ash-ground granulated blast furnace slag based self-curing bio-geopolymer concrete. The load-deflection characteristics of the beam specimen exhibited linear relationship up to yield load. After that the curve showed non-linear variation until it reached the ultimate load. Usually at mid span flexural crack occurred. All the mechanical properties such as compressive strength, splitting tensile strength and flexural strength of the geopolymer specimens increased jointly under the ambient curing temperature for all GPC specimens. From the experimental results, it was inferred that the inclusion of bio-additives such as Terminaliachebula and natural sugars improved the mechanical properties of self-curing bio-Geopolymer concrete even at lower concentration of 4 M NaOH.

5. **Gum Sung Ryu, et al (2013)** Have carried a study on The mechanical properties of fly ash -based geopolymer concrete with alkaline activators. The strength mechanism of reaction products was examined through SEM, EDS, XRD and via pore distribution analysis. The analysis of SEM-EDS enabled to verify the compactness of the structure of alkali-activated mortar.

The use of a mix of NaOH and sodium silicate with a mix ratio of 1:1 was shown to activate the geopolymerization of fly ash and achieve remarkable strength development. Geopolymer concrete is mainly more suitable for precast concrete products because the compressive strength of geopolymer concrete can be developed at a temperature that exceed 60°C.

6. **Samuel Demie et al (2013)** Have carried a study on Effects of micro-structure characteristics of interfacial transition zone on the compressive strength of self-compacting geopolymer concrete. It was observed that the development of the interfacial bond varies with utilization of different amount of SP and the developed interfacial bond determines the compressive strength and micro structure properties.

The utilization of super plasticizer not only improved the workability and compressive strength of SCGC but also enhanced the development of microstructure of concrete. 2.6% SP dosage could result SCGC compressive strength up to 51.52 Mpa tested at 28 days. Concrete specimen containing 7% of SP exhibited the highest compressive strength at all ages and enhanced the microstructure properties.

7. **DeepaBalakrishnan et al (2013)** Have carried a study on Properties of fly ash based geo-polymer concrete.

As the fly ash content increases it attains peak point (maximum compressive strength) beyond that the compressive strength goes on decreases. For geopolymer concrete, the curing period is an important factor when curing is done under ambient room temperature. The strength gain is found to be more than 60 percent at 90 days when compared to that of 28 days strength. The strength of heat cured specimen is found to be almost equal to the corresponding strength of 90 day ambient cured specimen.

8. **P. Yellaiah et al (2014)** Have experimented on Tensile strength of fly ash based geopolymer mortar.

The mixture composition for different alkaline activator to fly ash ratio with constant fly ash to sand ratio of 1:1.

Increase in alkaline activator to fly ash ratio of Geopolymer mortar increases the tensile strength and modulus of rupture.

Average direct tensile strength is found to be 0.12 times the compressive strength whereas the average flexural strength is found to be 0.18 times the compressive strength of Geopolymer mortar.

9. **Prabir et al (2013)** Have carried a study on Fracture behavior of heat cured fly ash based geopolymer concrete. As the applied load on the notched beam was increasing, no cracks were observed until the load reached its peak value. A crack appeared from the end of the notch and started to propagate fast in the ligament when the load reached its peak value.

The failure modes of the heat cured GPC specimens were generally more brittle than those of the OPC concrete specimens. The fracture planes of the GPC specimens were less tortuous than those of OPC concrete specimens.

The difference in the fracture behavior of GPC and OPC concrete is because of the higher bond and tensile strengths of GPC. The denser interfacial transition zone of GPC resulted in higher critical stress intensity factor and more brittle type of failure with smoother fracture plane as compared to OPC concrete.

III. CONCLUSION

The following concluded were drawn from a broad overview of the literature review.

- A. The basis of geo polymerization is a moderately new idea, and commercial implementation is in its origin. However, this new technology shows great potential for application in conventional construction as well as for construction in severe and demanding environments such as high-temperature applications and locations subject to chemical attack. The pozzolanic materials required for alkali-activation are readily available on a global level, and the cost-to-benefit ratio for the utilization of industrial waste is exceptional concerning traditional cementitious products used in the industry today.
- B. As a product known for its capacity to sustain the environment while maintaining the durability and structural integrity under severe conditions, geopolymer concretes are being proven as a worthy replacement for traditional methods of cementitious production and field application.
- C. The government can take necessary steps to extract sodium hydroxide and sodium silicate solution from the waste materials of chemical industries so that the cost of alkaline solutions required for the geopolymer concrete shall be reduced..

REFERENCES

- [1] Mehta, A. and Siddique, R. (2018). Sustainable geopolymer concrete using ground granulated blast furnace slag and rice husk ash: Strength and permeability properties. *Journal of Cleaner Production*, 205, pp.49-57.
- [2] Basar, H. and Deveci Aksoy, N. (2018). The effect of waste foundry sand (WFS) as partial replacement of sand on the mechanical, leaching and micro-structural characteristics of ready-mixed concrete. *Construction and Building Materials*, 35, pp.508-515.
- [3] Chen, Z., Li, J., Zhan, B., Sharma, U. and Poon, C. (2018). Compressive strength and micro structural properties of dry-mixed geopolymer pastes synthesized from GGBS and sewage sludge ash. *Construction and Building Materials*, 182, pp.597-607.
- [4] Rafeet, A., Vinai, R., Soutsos, M. and Sha, W. (2017). Guidelines for mix proportioning of fly ash/GGBS based alkali activated concretes. *Construction and Building Materials*, 147, pp.130-142.
- [5] Karthik, A., Sudalaimani, K. and Vijaya Kumar, C. (2017). Investigation on mechanical properties of fly ash-ground granulated blast furnace slag based self-curing bio-geopolymer concrete. *Construction and Building Materials*, 149, pp.338-349.
- [6] Ryu, G., Lee, Y., Koh, K. and Chung, Y. (2013). The mechanical properties of fly ash-based geopolymer concrete with alkaline activators. *Construction and Building Materials*, 47, pp.409-418.
- [7] Demie, S., Nuruddin, M. and Shafiq, N. (2013). Effects of micro-structure characteristics of interfacial transition zone on the compressive strength of self-compacting geopolymer concrete. *Construction and Building Materials*, 41, pp.91-98.
- [8] Joshi, S. and Kadu, M. (2012). Role of Alkaline Activator in Development of Eco-friendly Fly Ash Based Geo Polymer Concrete. *International Journal of Environmental Science and Development*, pp.417-421.
- [9] Yellaiah, P., Kumar Sharma, S. and Gunneswara Rao, T. (2014). Development of Fly Ash based Geopolymer behavior of Fly Cement. *Journal on Today's Ideas - Tomorrow's Technologies*, 2(1), pp.31-39.