

A Review of Experimental Study in Compressive Strength of Geopolymer Concrete Using Sodium Hydroxide and Sodium Silicate Solution

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Abstract: Due to rapidly growing population human activity in building Construction has been most important factor nowadays. Concrete is widely used and reliable material for construction. Some challenges in industry is global warming and insufficiency of construction material. One of the methods for replacing concrete constituent is the used of geopolymer which are using very less quantity of cement in concrete. Rapid infrastructure development taking place nowadays, Portland cement concrete is the most popular and widely used building material. However, due to the restriction of the manufacturing process and the raw materials there are two major drawbacks with respect to sustainability. About 1.5 tons of raw materials are needed in the production of every ton of Portland cement, at the same time about one ton of carbon dioxide (CO₂) is released into the environment during this production. The coal fired thermal power plants generate solid waste in the form of fly ash and pond ash. Disposal of these wastes is a major engineering challenge. Today research has combined sustainability with waste management leading to a wonderful product called geopolymer concrete. Modern-day geopolymer concrete are mostly made from low calcium fly ash and other waste materials activated by alkaline solutions using (NaOH or KOH with Na₂SiO₃ or K₂SiO₃). However, it should be noted that with the variation in the parameters such as Na₂SiO₃/NaOH ratio, Molarity of NaOH, curing temperature and curing time leads to changes in the strength. Geopolymer materials represent an innovative technology that is generating considerable interest in the construction industry, particularly in light of the ongoing emphasis on sustainability. This paper briefly reviews the studies such as molarity of sodium hydroxide and other ingredients in developing compressive strength of geopolymer concrete.

Keywords: Ground granulated blast furnace slag (GGBS). Fly ash, Eco-friendly concrete, sustainable concrete, fly ash-based geopolymer, Geopolymer binder, Sodium hydroxide (NaOH), Sodium silicate (Na₂SiO₃), geopolymer concrete.

I. INTRODUCTION

Concrete is the world's most versatile, durable, and reliable construction material. Large quantities of Portland cement are required for concrete. The consumption of Ordinary Portland Cement (OPC) causes pollution to the environment due to the emission of CO₂. Geopolymer concrete was introduced to reduce environmental pollution caused by production of Portland cement. In 1978, Professor Joseph Davidovits introduced the development of mineral binders with an amorphous structure, named geopolymers. Davidovits (1988; 1994) proposed that an alkaline liquid could be used to react with the silicon (Si) and the aluminium (Al) in a source material of geological origin or in by-product materials such as fly ash and rice husk ash 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. This was a class of solid materials, produced by the reaction of an aluminosilicate powder and an alkaline liquid. The production of cement releases large amounts of carbon dioxide (CO₂) to the atmosphere that significantly contributes to greenhouse gas emissions. It is estimated that one ton of CO₂ is released into the atmosphere for every ton of OPC produced. In view of this, there is a need to develop sustainable alternatives to conventional cement utilizing the cementitious properties of industrial byproducts such as fly ash and ground granulated blast furnace slag. On the other side, the abundance and availability of fly ash and GGBS worldwide create opportunity to utilize these by-products, as partial replacement or as performance enhancer for OPC. The wastes which are generated from the industries necessitates large area for disposal. Due to this disposal, it severely impacts the environment as well as human beings. To eradicate the above-said problems, the alternate binding material for Ordinary Portland Cement has been encouraged. If this type of alternate binder produced by using industrial by-products, it will nullify the effect of environment and also health issues due to their dumping. To wipe out these hurdles, a three-dimensional polymeric binder network was developed by Davidovits in the year 1978 termed as Geopolymer (Davidovits, 1979). These Geopolymer binders are formed mainly by mixing the source material which should be rich in

silica and Alumina with an alkaline solution. The selection of source material depends on numerous factors such as availability, price, type of application and particular demand of users.

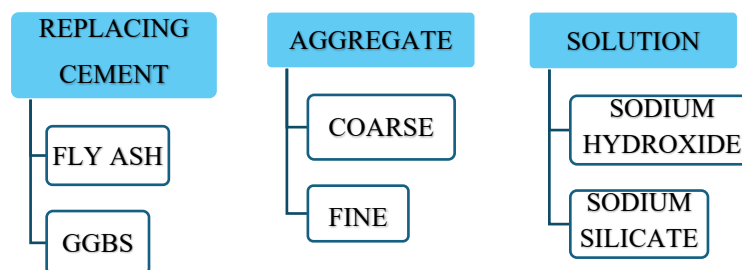
There is no standard mix design available for the design of Geopolymer Concrete. Only limited research information is available with a new mix design methodology for the fly ash based Geopolymer concrete. Construction has been most important human activity since ancient time. Concrete is widely used and reliable material for construction. Some challenges in industry is global warming and insufficiency of construction material. One of the methods for replacing concrete constituent is the used of geopolymer which are using very less quantity of cement in concrete.

II. LITERATURE REVIEW

Cement has been widely used in construction, Cement is the key ingredient in concrete as a binder material in the presence of water. A basic mixture of concrete has 10 to 15 percent of cement by volume. Raw materials required for cement manufacturing consumes more energy, these raw materials are heated in rotary kiln with a high temperature range from 1300°C to 1500°C to form clinker. Thus, global carbon dioxide (CO₂) emissions from cement production are 7 to 8 percent approximately. In fact, cement manufacturing needs high amount of energy consumption, for the high temperature needed for clinker production, this leads to the large amount of (CO₂) emission to the environment which leads to global warming and more frequent extreme weather events. This warming also causes oceans to absorb more (CO₂), leading to ocean acidification, which harms marine life and ecosystems.

To mitigate the environmental impact, geopolymer concrete is one as a sustainable alternative to the traditional concrete. Geopolymer concrete is produced by activating aluminosilicate rich industrial by-products such as fly ash, ground granulated blast furnace slag (GGBS) with alkaline activators Sodium Hydroxide and Sodium Silicate Solution

III. METHODOLOGIES



• **Fly ash:** Fly ash is a pozzolanic material with high alumina and silica content that gives a cementitious property in the presence of water in the geopolymer concrete.

• **GGBS:** Reduces the consumption of cement, resulting in lower carbon dioxide emissions and more sustainable construction products. It enhances the long-term strength, durability and workability of concrete when used as a partial cement replacement. Utilizing GGBS in concrete reduces the demand for virgin materials, thus conserving natural resources and reducing greenhouse gas emissions associated with cement production. Additionally, it helps in the management of industrial byproducts that would otherwise require disposal.

• **Coarse aggregate:** Coarse aggregate is a fundamental component of concrete, typically comprising particles larger than 4.75 millimeters. Coarse aggregate provides bulk and strength to concrete, contributing to its compressive strength and load-bearing capacity. The interlocking arrangement of coarse aggregate particles within the cement paste helps distribute applied loads and resist deformation under stress.

• **Fine aggregate:** Fine aggregate, also known as sand, is a crucial component of concrete that typically consists of particles smaller than 4.75 millimeters. Fine aggregate plays a key role in enhancing the workability and cohesion of concrete mixes. When combined with cement and water, the fine particles of sand coat the surfaces of coarse aggregate and cement particles, lubricating the mix and improving its plasticity. This makes the concrete easier to place, consolidate, and finish during construction.

• **Sodium hydroxide:** In geopolymer concrete, sodium hydroxide (NaOH) plays a crucial role as an activator in the geopolymerization process. Sodium hydroxide, typically in the form of a concentrated solution, serves as the primary activator in geopolymer concrete. When mixed with the aluminosilicate precursor materials, such as fly ash or slag, sodium hydroxide initiates the geopolymerization reaction by breaking down the silica and alumina components and forming polymeric chains.

• **Sodium silicate:** Sodium silicate can contribute to the development of durable geopolymer concrete by promoting the formation of dense microstructures and enhancing the resistance to chemical attack, abrasion, and moisture ingress. The

incorporation of sodium silicate in geopolymer mixes can improve the long-term performance and durability of concrete structures.

III. CONCLUSION

According to this review following conclusion can be made, To study the effect of sodium hydroxide molarity in the compressive strength of geopolymer concrete can be made. According to the molarity of the sodium hydroxide solution the gain in the compressive strength of geopolymer concrete can be analyse and apply to the various constructions. Due to the use of Fly ash, it is a primary source material rich in silica and aluminum oxides used to create the binder in geopolymer concrete and GGBS often blended with materials like fly ash to create a strong and sustainable alternative to traditional cement.

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