



DETECTING THE BENDING MOMENT OF GEOPOLYMER CONCRETE USING MICROSLAG

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ABSTRACT

Humans are creating new ideas and technology in the twenty-first century that make life easier and more accessible. However, in the midst of these innovations, we neglected the earth's natural ecosystem. The preservation of our natural resources is our duty. As is well known, the demand for Ordinary Portland Cement (OPC) is rising as a result of global infrastructure development. Ordinary Portland cement is becoming more and more in demand. To replace the use of cement new era of geopolymer concrete introduced. In present study we try to obtain bending moment of beam using combination of GGBS, flyash and microslag. So as to utilize waste in construction at ambient temperature.

1. INTRODUCTION

The manufacture of OPC is known to cause environmental problems.

The production of OPC requires a significant amount of energy. The Approximately one ton of CO₂ is released during the manufacturing of one ton of cement (Roy, 1999). Reduced use of natural resources, technology that uses less energy, and decreased carbon dioxide production are all necessary to create environmentally friendly concrete. The goal of the current study is to investigate the potential use of fly ash in the production of geopolymer concrete by creating a binding material using alkalis like sodium hydroxide and sodium silicate. The cementing substance will serve as a substitute for cement. This will deal with the problems of lowering greenhouse gas emissions, lowering energy use, and disposing of byproducts in an environmentally responsible manner. The impact of several alkaline activator-related parameters on the compressive strength of geopolymer concrete under various curing conditions is also examined and presented, including the molar concentration of sodium hydroxide solution, the mass ratio of alkaline liquid to fly ash, and the mass ratio of sodium silicate to sodium hydroxide. In the temperature range of 25 to 45 degrees Celsius, ambient curing conditions are the most practical and cost-effective. When compared to ambient curing conditions, oven-dried curing conditions significantly increase the strength of concrete by controlling hot air curing at a specific temperature for the necessary amount of time, (S. V. Joshi and M. S. Kadu, 2012). GPC (Geopolymer Concrete) uses fly ash and ground granulated blast furnace slag (GGBFS) in a 50:50 ratio to totally replace cement with an alkaline solution ratio maintained at 1:2.1 with a molarity of 8M at

ambient temperature up to 360C, (B. S. Pruthviraj, Shrishail B Anadinni,2022). Geopolymer concrete has shown remarkable strength, little shrinkage, and resistance to fire, acid and sulphate corrosion, freeze-thaw resistance, and the reaction of alkali with aggregate ,(Ganesh, Chithambar and Muthukannan, Muthiah,2018) . Thus in the present study geopolymer concrete is produced by adding micro slag at ambient temperature and its analysis is done.

2. LITERATURE REVIEW

Fly ash is a fine particulate material that is separated from the flue gas of coal-fired power plants and is rich in silica and alumina. Because fly ash production is constantly increasing and causing major environmental pollution issues, fly ash should be treated as a valuable resource or reused as a raw material in new technology with good properties. Class F fly ash has been thought of as porcelain or pozzolanic materials and can be activated by high alkaline solutions to act as a binder through chemical polymerization reactions. (Swanepoel, (2002).) Depending on the raw material and production conditions, geopolymers' primary characteristics include high compressive strength, low shrinkage, acid resistance, fire resistance, and low thermal conductivity. (Duxson, 2007) It was discovered that the grinding circumstances, such as the type of mill and residence duration, significantly affect the specimen's strength. The number and makeup of the glassy phase, as well as the distribution of fly ash's particle sizes, determine its reactivity (Kumar and Kumar, 2011; Low Fly ash's reactivity causes delayed binding and early strength development. It has been demonstrated that, in contrast to uncalcined materials, calcined materials—such as fly ash, metakaolin, and granulated blast furnace slag—have greater

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reactivity during the geopolymerization reaction (Komintas and Zaharaki, 2007). According to Kumar and Kumar (2011), calcination activates materials from crystalline to amorphous structure, and additional energy stored in the material with the same fineness triggered in different types of mill resulted in varied mechanical and structural features of geopolymer. Sinha and Kumar (2014), Strength growth was examined in relation to Si/Al ratio and alkali concentration. Higher alkali concentrations and Si/Al ratios were found to considerably increase strength. (Ning Li, Caijun Shi, Zuhua Zhang, Hao Wang and Yiwei Liu, 2019) The widespread use of GPC in the construction sector is hindered by the absence of a suitable mixture design approach, notwithstanding industry traditions. (Albitar M, Visintin P, Ali M.S.M and Dreehler M, 2015) A lot of the design mixtures that previous scholars have suggested are based on trial-and-error techniques. According to reports, the liquid in the mix design has a bigger influence on the compressive strength produced in GPC. (Y.H. Mugahed Amran, Rayed Alyousef, Hisham Alabduljabbar and Mohamed El-Zeadani 2019), the advantage of geo-polymer concrete is that it can replace cement by adding cementitious materials and alkali activated solutions. Geo-polymer concrete is a relatively new, innovative, and eco-friendly engineering material as opposed to ordinary concrete.

3. MATERIAL USED

3.1 Flyash: Minimal calcium concentration Class F fly ash was used in this experimental effort. This fly ash came from the Kota Thermal Power Plant in Kota. The amount of fly ash content is the primary factor in this design. The best predictor of concrete behavior is usually the calcium (CaO) concentration of FA.

3.2 Ground-granulated blast-furnace slag (GGBS): is a glassy, granular substance that is dried and ground into a fine powder after molten iron slag, a byproduct of the production of iron and steel, is quenched in water or steam in a blast furnace. (Bernal et al 2012)(Deb et al 2014), When mixed with FA, the average amounts of GGBFS used in GPC manufacture vary from 10 to 80 kg per cubic meter of GPC, or up to 400 kg per cubic meter of GPC alone.

3.3 Alkali Activated Solution (AAS): AAS is a combination of sodium silicate (Na₂SiO₃) and sodium hydroxide (NaOH). According to IS 10262: 2019, the maximum amount of water for one cubic meter of concrete. According to several studies, it is an exothermic reaction that releases heat, thus we prepared the mixture at least 24 hours before using the sodium hydroxide (NaOH) solution. After preparing the 13M concentration solution and letting it sit at room temperature for a full day, we added the sodium hydroxide solution to the dry mixture.

3.4 Aggregates

3.4.1 Coarse aggregates: The coarse aggregates employed in this investigation had a maximum size of 20 mm and were sourced locally.

3.4.2 Fine Aggregates: According to IS: 383-1970, fine aggregates were deemed adequate.

3.5 Micro slag: Based on blast furnace slag, micro slag is

an ultrafine low calcium silicate material with controlled granulation and high reactivity.

4. MIX DESIGN PARAMETERS

Following mix design parameters were used to prepare the specimen for flexural strength.

Table 1: Mix design proportions

Mixture	Proportions
Flyash	85 %
GGBS	10 %
Micro slag	5 %
Coarse Aggregate	1133.78 kg/m ³
Fine Aggregate	377.78 kg/m ³
Mass of NaOH soln	66.66kg/m ³
Mass of Na ₂ SiO ₃ soln	133.33kg/m ³
Molarity	13M
Alkaline activator ratio	2
Alkali/Flyash	0.45

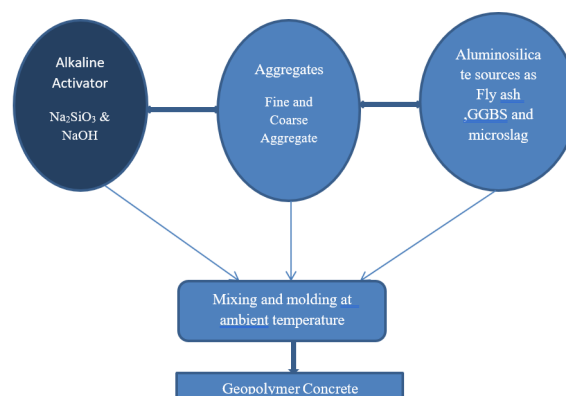


Figure 1: Preparation of Geopolymer concrete

5. RESULTS AND DISCUSSION

Tests were carried out in compliance with the previous mix design. In its new state, GPC had a shiny sheen. It is evident where the In regular concrete, slump increases with the water-to-cement ratio; GPC showed the same behavior. The specimens were cured at room temperature. The specimens can be cured at room temperature because GGBFS is employed in addition to fly ash, but GPC with fly ash alone needs to be heated. Beam specimen for flexural test were prepared and tested at 7 days and 28 days. Beams were casted for testing the bending moment of prepared sample. The peak load value in a flexural testing machine is used to calculate the beam specimen's moment bearing capability. In the current investigation, we found that their moment carrying capacity rises as the percentage of micro slag increases. The size of the sample taken as 100x100x500mm. Additionally, a graph that displays each beam specimen's moment carrying capability is presented. Use of microslag in given mixture enhances the strength. Figure 2 depict the variation pattern in the moment at 7 and 28 days.

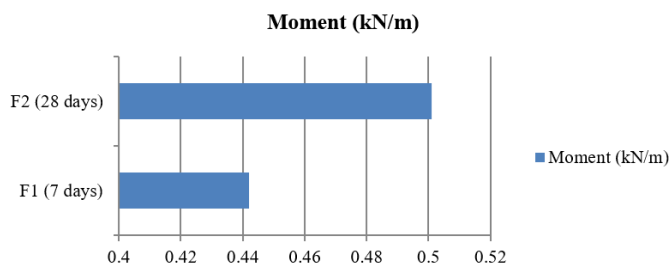


Figure 2: Moment of prepared geopolymer concrete sample at 7 and 28 days

6. CONCLUSION

It is clear that for the past ten years, the global climate has been impacted by global warming. Creating alternative concrete production techniques is one strategy to cut greenhouse gas emissions. Naturally, it won't undo the harm that has already been done, but it will lessen future injury. The key to our salvation is Geopolymer Concrete (GPC). GGBS and micro slag were used to partially substitute fly ash in geopolymer concrete mixtures. The findings drawn from the experimental test results are as the bending moment of the beam increases as the amount of micro slag increases. There is 113.34% increase in bending of beam in 28 days from 7 days. All results were obtained at ambient temperature. Ambient curing instead of heat curing is preferable.

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