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Geopolymer Concrete Based on Class C Fly ash Cured at Ambient Condition

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ABSTRACT

In recent years, geopolymers, as a new class of green cement binders, have been considered as an environmental-friendly alternative to Ordinary Portland Cement (OPC), which can potentially reduce the negative environmental impacts of OPC. Geopolymers are inorganic alumina-silicate materials produced from raw materials in combination with an alkaline activator solution. The alkaline activator solution is one of the pillars of the geopolymerization process, playing an important role in the formation of crystalline structures of Si and Al. Therefore, it seems necessary to study the impact of various alkaline activator solutions on the mechanical strength of Geopolymer Concrete (GPC). On the other hand, in most previous research in this regard, GPC based on Class F fly ash and high-temperature curing condition have been studied. Hence, in this research, Class C fly ash, and ambient curing conditions were used to make GPC. The obtained results indicated that in ambient curing conditions, using sodium hydroxide and sodium silicate results in higher compressive strength and lower permeability compared to potassium-based (potassium hydroxide and potassium silicate) and a combination of sodium potassium-based alkaline activator solutions. But, at elevated curing temperatures, a potassium-based activator provided higher compressive strength. Moreover, simultaneous inclusion of NaOH and KOH led to a decline the compressive strength. Furthermore, the obtained results indicated that increasing the NaOH and KOH concentration resulted in higher compressive strength. The optimal SiO2/Na2O ratio was 2 in the case of using 14M NaOH solution and 2.5 in the case of using 10M NaOH solution.

Keywords: Geopolymer concrete, Fly ash, Alkaline activator solution, Compressive strength, Resistance to acidic condition.

1. INTRODUCTION

Pollution and climate change due to global warming have become the most significant environmental concerns worldwide [1]. Greenhouse gas emissions are the main contributing factor to global warming, with carbon dioxide (CO_2) having the greatest share (65%) among other greenhouse gases [2]. The production process of Ordinary Portland Cement (OPC) is identified as one of the major sources of CO2 emission and energy consumption. OPC production accounts for approximately 5% of global energy consumption. Furthermore, the Production of 1 ton of OPC releases approximately 1 ton of CO_2 into the environment [3] and consumes 1.5 tons of raw materials [4]. Therefore, it seems necessary to find an alternative to OPC. Pollution and climate change due to global warming have become the most significant environmental concerns worldwide [1]. Greenhouse gas emissions are the main contributing factor to global warming, with carbon dioxide (CO_2) having the greatest share (65%) among other greenhouse gases [2]. The production process of Ordinary Portland Cement (OPC) is