

Effect of Curing Time on the Formation, Compression Strength, and Morphology of Pre-Treated Fly Ash Geopolymers

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Structured Abstract

Background: Due to its richness in aluminosilicate compounds, fly ash geopolymer has emerged as a potential replacement for Ordinary Portland Cement (OPC). However, the presence of unburned carbon in raw fly ash is negatively impacting its reactivity, which may hinder its use as the precursor in geopolymer concrete.

Methods: This method was conducted to reduce the unburned carbon in raw fly ash and study the effect of curing time on fly ash geopolymer. Raw fly ash was heat-treated at 600°C over the time intervals of 1, 2, 3, and 4 hours, then subjected to CHNS, FTIR, and SEM analysis. The heat-treated fly ash was then used to prepare the geopolymer samples. The fly ash geopolymer mixture consists of mass ratio of 12 M sodium hydroxide (NaOH) and sodium silicate (Na₂SiO₃) of 2.5:1 and fly ash and alkaline activator in a mass ratio of 0.5:1. The molded fly ash geopolymer samples were then examined for the compressive strength, FTIR, and SEM analysis on days 7, 14, 21, and 28.

Results: CHNS analysis revealed that carbon content dropped significantly from 4.25% to just 0.27% after 2 hours of heat treatment. This finding is further supported by the loss of ignition (LOI) calculated. Interestingly, a progressive lightening in colour can be observed visually as the heating duration increases, and an enhancement in the Si–O–(Si,Al) peak intensities can be seen in the FTIR spectra. The SEM micrograph shows cleaner particles with reduced porosity. With the increase of curing time, FTIR spectra show a decrease in hydroxyl and carbonate peaks. A steady increase in compressive strength can also be seen occurring from 0.27 MPa (day 7) to 0.64 MPa (day 28), with the SEM analysis revealing a denser and more compact matrix.

Conclusion: 2-hour heat-treatment duration is effective to reduce unburned carbon in raw fly ash. In addition, with increased curing time, geopolymerization is more progressed. From this study, valuable information on optimizing the pretreatment of fly ash and curing conditions of fly ash-based geopolymer is provided, supporting an efficient and sustainable fly ash geopolymer production.

Keywords: Fly Ash, Geopolymer, Heat Treatment, Curing Time

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