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Alkaline Activator Dependence Morphological, Compression Strength and Formation of Fly Ash Geopolymer

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Structured Abstract

Background: Concrete, which consist of cement is widely used in the development of housing and infrastructure. Nevertheless, there are environmental and health concerns that arises from the production of cement. Fly ash (FA), considered as waste from the generation of electricity was utilized to produce FA geopolymer which can be used as an alternative to Portland cement. The purpose of this study is to investigate the influence of different concentration of sodium silicate (Na_2SiO_3) on FA geopolymer formation and to elucidate the chemical and physical properties of FA geopolymer by characterization using Fourier-transform Infrared Spectroscopy (FTIR) to investigate new bonding, Scanning Electron Microscope (SEM) to analyse morphology and microstructure and compressive strength test to test geopolymers compressive strength.

Methods: FA was dried in the oven at 60 °C for 48 hours before being added into alkaline activators (AA) which are sodium hydroxide (NaOH) and Na_2SiO_3. The different concentration of Na_2SiO_3 were obtained by varying the ratio of AA/FA to 0.30, 0.35, 0.40 and 0.45, with fixed concentration of NaOH at 15 M. The mixture was poured into cylindrical moulds and left to age for 24 hours at room temperature before curing at 70 °C overnight. The FA geopolymers were further aged for seven days at room temperature before characterization.

Results: The FA geopolymer with different concentrations of Na_2SiO_3 produced were structurally stable. FTIR analysis reveals a new bonding in the FA geopolymer compared to FA. The wavenumber corresponding to Si-O-Si/Al-O-Si stretching is pushed to lower values as concentration of Na_2SiO_3 is increased, indicating larger aluminum-rich aluminosilicate network. SEM images shows FA with smooth cenospheres or particulate with varied sizes and geopolymers with different ratios of AA/FA had agglomeration and particulate with greater agglomeration shown in ratio 0.30. Compressive strength test showed ratio 0.40 had the greatest compressive strength, indicating a structurally stronger geopolymer.

Conclusion: In conclusion, the influence of different concentration of Na_2SiO_3 in FA geopolymer production was successfully investigated and the chemical and physical properties of geopolymer were elucidated using FTIR, SEM and compressive strength test. The optimum ratio of AA/FA is 0.40 as the geopolymer can withstand the highest load.

Keywords: Fly ash, geopolymer, alkaline activator, sodium silicate

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