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Effect of Sodium Aluminate on Compressive Strength of Geopolymer at Elevated Temperatures

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Abstract : Geopolymer is an inorganic material synthesized by alkali activation of source materials rich in soluble SiO₂and Al₂O₃. Many researches have studied the effect of aluminum species on the synthesis of geopolymer. However, it is still unclear about the influence of Al additives on the properties of geopolymer. The current study identified the role of the Al additive on the thermal performance of fly ash based geopolymer and observing the microstructure development of the composite. NaOH pellets were dissolved in water for 14 M (14 moles/L) sodium hydroxide solution which was used as an alkali activator. The weight ratio of alkali activator to fly ash was 0.40. Sodium aluminate powder was employed as an Al additive and added in amounts of 0.5 wt.% to 2 wt.% by the weight of fly ash. The mixture of alkali activator and fly ash was cured in a 75°C dry oven for 24 hours. Then, the hardened geopolymer samples were exposed to 300°C, 600°C and 900°C for 2 hours, respectively. The initial compressive strength after oven curing increased with increasing sodium aluminate content. It was also observed in SEM results that more amounts of geopolymer composite were synthesized as sodium aluminate was added. The compressive strength increased with increasing heating temperature from 300°C to 600°C regardless of sodium aluminate addition. It was consistent with the ATR-FTIR results that the peak position related to asymmetric stretching vibrations of Si-O-T (T: Si or Al) shifted to higher wavenumber as the heating temperature increased, indicating the further geopolymer reaction. In addition, geopolymer sample with higher content of sodium aluminate showed better compressive strength. It was also reflected on the IR results by more shift of the peak position assigned to Si-O-T toward the higher wavenumber. However, the compressive strength decreased after being exposed to 900°C in all samples. The degree of reduction in compressive strength was decreased with increasing sodium aluminate content. The deterioration in compressive strength was most severe in the geopolymer sample without sodium aluminate additive, while the samples with sodium aluminate addition showed better thermal durability at 900°C. This is related to the phase transformation with the occurrence of nepheline phase at 900°C, which was most predominant in the sample without sodium aluminate. In this work, it was concluded that sodium aluminate could be a good additive in the geopolymer synthesis by showing the improved compressive strength at elevated temperatures.

Keywords : compressive strength, fly ash based geopolymer, microstructure development, Na-aluminate
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