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Influence of Variable Calcium Content on Mechanical Properties of Geopolymer Synthesized at Different Temperature and Moisture Conditions

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Abstract : In search of a sustainable construction material, geopolymer has been investigated for past decades to evaluate its advantage over conventional products. Synthesis of geopolymer requires a source of aluminosilicate mixed with sodium hydroxide and sodium silicate at different proportions to maintain a Si/Al molar ratio of 1-3 and Na/Al molar ratio of unity. A comprehensive geopolymer study was performed with Metakaolin and Class C Fly ash as primary aluminosilicate sources. Synthesized geopolymer was analyzed for time-dependent viscosity, setting period and strength at varying initial moisture content, curing temperature and humidity. Different concentration of $Ca(OH)_2$ and $CaSO_4.2H_2O$ were added to vary the amount of calcium contained in synthesized geopolymer. Influence of calcium content in unconfined compressive strength behavior of geopolymer were analyzed. Finally, Scanning Electron Microscopy-Energy Dispersive Spectroscopy (SEM-EDS) was performed to investigate the hardened product. It was observed that fly ash based geopolymer had shortened setting time and faster increase in viscosity as compared to geopolymer synthesized from metakaolin. This was primarily attributed to higher calcium content resulting in formation of calcium silicate hydrates (CSH). SEM-EDS was performed to verify the presence of CSH phases. Spectral analysis of geopolymer prepared by addition of $Ca(OH)_2$ and $CaSO_4.2H_2O$ indicated higher CSH phases at higher concentration. It was observed that lower concentration of added calcium favored strength gain in geopolymer. However, at higher calcium concentration, decrease in strength was observed. Strength variation was also observed with humidity at initial curing condition. At 100% humidity, geopolymer with added calcium presented higher strength compared to samples cured at ambient humidity condition (40%). Reduction in strength in these samples at lower humidity was primarily attributed to reduction in moisture content in specimen due to the formation of CSH phases and loss of moisture through evaporation. For low calcium content geopolymers, with increase in temperature, gain in strength was observed with maximum strength observed at 200 ˚C. However, samples with higher calcium content demonstrated severe cracking resulting in low strength at elevated temperatures.

Keywords : calcium silicate hydrates, geopolymer, humidity, Scanning Electron Microscopy-Energy Dispersive Spectroscopy, unconfined compressive strength
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