

Interaction of silica fume on flexural properties of 10 mm-thickness geopolymers based on fly ash and ladle furnace slag under the thermal conditions

Abstract

Studies regarding the properties of geopolymers with silica fume addition at elevated temperature exposure were rarely reported. This paper evaluates the effect of silica fume inclusion on the flexural and thermal performance of geopolymers based on fly ash (FA) and ladle furnace slag (LFS) with thickness of merely 10 mm. Fly ash/slag (FS) geopolymer was prepared by mixing FA and LFS using a weight ratio of 60:40 with an alkali activator (sodium silicate and sodium hydroxide). Silica fume (1, 2, 3, and 4 wt%) was added to prepare FSF geopolymers. The geopolymers were then subjected to the elevated temperature up to 1100 °C after 28-days of curing. Higher flexural strength of 9.1 MPa was achieved in unexposed FSF geopolymers with 3 wt% silica fume addition as compared to unexposed FS geopolymers (7.8 MPa). Flexural strength degraded with higher silica fume content of 4 wt%. Heat treatment significantly improved the flexural strength of geopolymers. Both FS and FSF3 geopolymers had increased strength of 208.9% to 24.1 MPa at 1100 °C and 192.3% to 26.6 MPa at 1000 °C, respectively as compared to the unexposed specimen. The inclusion of silica fume with extreme fineness improved the interconnectivity of the geopolymer matrix, densifying the geopolymer structure and thus enhancing the thermal resistance of geopolymers. However, the dense matrix with low flowability of FSF3 geopolymers could not sustain the high thermal stress and caused strength degradation and crack formation at a high temperature of 1100 °C. Even so, the flexural strength of 1100 °C heat-treated FSF3 geopolymer was 13.2% higher than the unexposed specimen. This demonstrated that silica fume could be incorporated in enhancing the thermal resistance and high strength achievement in geopolymers.

Keywords

10 mm-thickness; Elevated temperature; Flexural properties; Geopolymer; Silica fume