

Alkali-Activated Complex Binders of Fly Ash and Other Calcium Bearing Materials

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ABSTRACT

Complex binders of fly ash and other calcium bearing materials activated by sodium silicate and sodium hydroxide solution were studied. Hardened binders made only from fly ash (F), fly ash with 40 wt% cement (F-C40%), fly ash with 10 wt% flue gas desulphurization (FGD) gypsum (F-G10%), and fly ash with 10 wt% water treatment sludge (F-S10%) had better mechanical performance compared to the binders using other mix ratios. Most of the activated products were in the non-crystalline state as X-ray (XRD) diffraction analysis showed a broad diffuse halo. Using Fourier transform infrared spectroscopy (IR), asymmetric stretching of Al-O and Si-O bonds and Si-O-Si bending bands appeared as the main peaks. Scanning electron microscope (SEM) pictures of the F, F-C40%, F-G10%, and F-S10% samples also showed that amorphous synthesis products were formed around the spherical fly ash. Further analysis using energy dispersive X-ray analysis (EDXA) indicated the main products of the F, F-G10% and F-S10% samples were geopolymeric gels. However, in the F-C40% sample, calcium silicate hydrate (CSH) gel and geopolymeric gel were formed simultaneously. The binding properties of the amorphous alkali aluminosilicate geopolymer gel and CSH gel contribute to the mechanical strength of the complex binders. In conclusion, fly ash and other calcium bearing materials, such as alkali-activated complex binders, can be widely utilized in various applications such as in building materials and solidification/stabilization materials.

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