Parames Kamhangrittirong 2012: Engineering Properties of Geopolymer from High Calcium Fly Ash. Doctor of Engineering (Civil Engineering), Major Field: Civil Engineering, Department of Civil Engineering. Thesis Advisor: Associate Professor Prasert Suwanvitaya, Ph.D. 210 pages.

Geopolymer is an innovative material resulting from the reaction of sodium hydroxide, sodium silicate and silica and alumina in aluminosilicate materials. It can be synthesized with high alkaline solution at room temperatures. Because of the low carbon dioxide production and because it involves the utilization of fly ash, essentially a waste material, geopolymer has been looked upon as an attractive alternative to the use of cement. In this study, different concentrations of sodium hydroxide solutions (8, 10 and 12 molars) were employed to activate high calcium fly ash. The mole ratios of silicon dioxide to sodium oxide (Ms) in alkali solutions were 0.60, 0.70, 0.80, 0.90, 1.00, 1.10, 1.20, 1.30 and 1.40. The weight ratios of fly ash content to alkali solution (F/A) were 60:40, 65:35 and 70:30. Engineering properties of geopolymer pastes were studied. The composition, microstructure and influence on harden properties were investigated by electron microscope with energy dispersive X-Ray spectrometer, X-Ray diffractrometer and Fourier transform infrared spectrometer. Applications of suitable mixtures for construction materials were also studied.

Generally, increasing the molarity of sodium hydroxide solution and decreasing the mole ratio of silicon dioxide to sodium oxide in alkali solution decreased the workability of the geopolymer paste. Increasing fly ash proportion also resulted in the decrease of the workability. The maximum compressive strengths of geopolymer specimens above 30 MPa were reached after curing at room temperature for 28 days. The results indicated that increasing the fly ash to alkali activators ratio and molarity of sodium hydroxide solution significantly increased the compressive strength. The optimum Ms for highest compressive strength were 0.90 for F/A ratio 60:40, 0.80 for F/A ratio 65:35 and 0.70 for F/A ratio 70:30, respectively.

The SEM and TEM micrographs of geopolymer revealed a homogeneous amorphous structure. The EDX results confirmed that major elements of microstructure consisted of Si, Al and O. The XRD patterns of fly ash based geopolymer revealed non-crystalline structure. The dissolution of aluminosilicate in raw materials could be seen from the changes in the XRD patterns. The IR spectrums revealed major chemical bonding of Si-O-Al. The selected optimum mixture of geopolymer showed the potential for application, as mortar-like material.

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