別紙様式８

研　究　主　論　文　抄　録

論文題目

Utilization of By-products for Concrete: Development of One-part Mixing of Fly Ash, GGBFS and Silica Fume AAM and Applicability of Paper Sludge Ash

（副産物のコンクリートへの利用：フライアッシュ,高炉スラグ微粉末,シリカフュームを利用したアルカリ賦活材料の一液混合法の開発とペーパースラッジ灰の適用性について）

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主論文要旨

OPC (ordinary Portland cement) is not an environmentally friendly construction material and it is a major contributor to global warming. AAM (alkali-activated material) which is mainly produced by aluminosilicate precursors and AA (alkaline activators) can be a substitute for the OPC due to its extraordinary properties such as high strength and durability. Moreover, AAM contains some by-products such as fly ash and slag, and compare to the OPC lesser amount of CO2 is emitted for their production. Therefore, they are adopted as environmentally friendly materials. Corrosive and viscosity effects of alkaline materials cause difficulty in handling the materials by common people and make it tough to cast them on site. Therefore, they are made as precast elements which increases the cost of their production. To overcome the problem, a one-part mixing method is proposed by some researchers but they found that the quality of AAM made by the one-part mixing method is lower than the one made by the two-part mixing method. Furthermore, low-calcium fly ash-based AAM has some problems such as a long setting time and low compressive strength when cured at ambient temperature curing. This research aimed to solve the aforementioned problems and develop a one-part mixing method of AAM.

The properties of one-part mixed AAM mortar were characterized. It was found that the quality of the AAM made by the aforementioned method was much lower than the conventional and OPC mortar. The compressive strength of the AAM was increased with an increase in slag amount but the flowability of the AAM was much lower due to the quick setting of the fresh mortar. The higher reactivity of the slag caused the

problem. Therefore, sucrose was added to the mortar to delay the setting time. Sucrose increased the setting time and improved the flowability, compressive strength, and drying shrinkage of the AAM.

The flow and compressive strength properties of AAM made by one-part and two-part mixing methods were tested and compared. It was found that the AAM made by the two-part mixing method had much better flowability and compressive strength than the one-part mixed AAM. Therefore, the solubility test of solid alkaline activators was conducted and it was revealed that sodium metasilicate couldn't be dissolved well in a solvent at a temperature around 25°C. So it was concluded that when 32% sodium metasilicate is used for making AAM using one-part mixing method, water or a solvent need to have a temperature of around 40°C. In addition, the properties of AAM made by sodium metasilicate were investigated. The AA solution made by sodium metasilicate was smooth and fluent but it was susceptible to a lower temperature than 30°C as a crystallization of the solution could easily occur. Hot mixing conditions played a positive role in increasing the flowability of the mortars. Compressive strength of 40MPa and flexural strength of 6.1 MPa were achieved by AAM using granular sodium metasilicate.

As mentioned before that low-calcium fly ash-based AAM has a much longer initial and final setting time and low compressive strength when cured at ambient temperature conditions. So in this experiment, the influence of the type and concentration of sodium silicate was studied on the setting time, flowability, and compressive strength of low-calcium fly ash-based AAM. It was found that the decreased concentration of sodium disilicate had a considerable positive effect on the setting time and compressive strength of AAM cured at ambient temperature.

In addition, this research also aimed to study the influence of recycled waste materials such as recycled coarse aggregate produced by pulsed power technology, paper sludge ash, and silica fume on properties of ordinary Portland cement concrete. It was found that both silica fume and paper sludge ash showed their pozzolanic reactivity and improved some of the properties such as compressive strength of both conventional and recycled concrete. furthermore, the high-quality recycled aggregate was produced by pulsed power technology, and using the aggregate didn't have a negative effect on the properties of concrete.

Keywords: Alkali-activated material, One-part mixing, Alkaline activators, Fly ash, Slag, Solubility, Recycled aggregate, Paper sludge ash.