EFFECT OF MICROSTRUCTURE ON PHYSICAL PROPERTIES OF SLAG AND FLY ASH BASED ALKALI ACTIVATED MATERIALS

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Nowadays cementitious materials such as concrete and mortar are widely used in many fields. One of the examples is an application for construction of buildings. However, there is one problem about using cement. In producing cement, CO2 emissions are unavoidable. In order to reduce the amount of CO2 emissions in the process of cement production, blended cements that are partly replaced by by-products are recommended. By-products that are used for blended cements production are mainly blast furnace slag which is by-product of steel production, and fly ash which is generated from thermal power plant. Even blended cements include cements in them, there is still a problem of CO2 emissions. Therefore, the production of geopolymer concrete have been increased for reducing CO2 emission.

Geopolymer concrete is required to have the same performance such as compressive strength, elastic modulus, durability of chloride ion and resistance to sulfate attack as cement concrete. There are numerous researches putting focuses on these properties, but the effect of chemical composition and microstructure on physical properties are not clear, because blast furnace slag and fly ash are by-product and their compositions are difficult to control. Take this situation into account, in our study, physical properties and microstructure were investigated to evaluate the effect of microstructure on physical properties. Specifically, in order to identify the microstructure, we focused on degrees of reaction of blast furnace slag and fly ash which are rarely taken into consideration in previous studies.

In our study, we conducted experiments for identifying physical properties and microstructure. In order to identify physical properties, we conducted uniaxial compression test and measured electric resistivity and transport of chloride ion. For investigating microstructure, degrees of reaction of blast furnace slag and fly ash were measured by scanning electron microscope (SEM) with backscattered electron mode. Degree of reaction of slag was calculated from brightness level of backscattered electron image and degree of reaction of fly-ash was calculated by point-counting method of backscattered electron image. Specific surface area was also calculated by BET theory from the result of N2 gas adsorption method. The chemical composition of reaction products was measured by energy dispersive X-ray spectroscopy (EDX). In EDX, we focused on the elements of Ca, Si, Al and K.

As a result, compressive strength and electric resistivity of geopolymer paste increased with the increase of replacement ratio of blast furnace slag and specific surface area. Diffusion coefficient of chloride ion decrease with the increase of replacement ratio of slag. Degree of reaction of slag and fly ash in this study were almost same despite of different replacement ratios of slag and fly ash, it means that the amount of reaction products from slag increase with replacement of slag. It became clear that calcium concentration in reaction product had an influence on the compressive strength considering relationship between compressive strength and calcium concentration in reaction product. In addition, a good correlation was seen in the amount of reaction product and compressive strength. Therefore, we could see that the amount of reaction products and concentration of calcium in reaction products is significantly important in evaluating physical properties of geopolymer paste.