대나무 재를 혼합한 플라이에쉬 지오폴리머 콘크리트의 물리적 특성에 대한연구

Mechanical Properties of Fly Ash Geopolymer Concrete Incorporating Bamboo Ash

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Abstract

Malaysia, as a tropical rainforest country, enjoys an abundance of bamboo plant that proliferate throughout the country. The application of geopolymer technology has become a trend and preserve the environment from harm. Fly ash geopolymer concrete has low early strength and requires 24 hours for the concrete to harden. Thus, the presence of calcium and potassium content in bamboo ash could remedy this problem. Besides, there is no research regarding the use of bamboo ash as a binder in geopolymer concrete. Therefore, the presence of bamboo ash could improve the research field with the use of agriculture waste in a building construction. This research aim is to use bamboo ash in the production of fly ash geopolymer concrete. The specimens were casted in 100mm x 100mm x 100mm cubes and sodium based activator were used as the alkaline solutions. The binders are formulated with different binder ratio. All test specimens were cured at ambient temperature (23° C -25° C) and 100% fly ash was chosen as control specimen. To determine the mechanical properties of fly sh geopolymer concrete with the presence of bamboo ash, compressive strength test was conducted. The test results depicted that as the percentage of bamboo ash decreases, compressive strength increases. Also, the addition of 5% of bamboo ash into fly ash geopolymer concrete could improve the early strength in 7 days. The results were proven with the result explained by X-ray fluorescence (XRF) and X-ray diffraction (XRD). Therefore, it can be concluded that the addition of bamboo ash improved the properties of fly ash geopolymer concrete at early ages.

키 워 드 : 플라이애쉬, 대나무재, 지오폴리머
Keywords : fly ash, bamboo ash, geopolymer

1. 서 론

Geopolymer is an inorganic composite which is produced by synthesizing pozzolanic materials under highly alkaline hydroxide and/or alkaline silicate [1]. Although the heat curing of geopolymer systems need some input, this cementless concrete is found to be one of the better alternatives for ordinary Portland Cement (OPC) concrete in terms of reducing the high carbon dioxide footprint of OPC production. The production of bamboo charcoal has increased and its application especially in heathcare, cooking, water purification and gardening have grown significantly. Although rich in silica, the poor performance of bamboo ash is owing to the presence of silicate material. Due to absence of alumina, it is attractive for combination with other material which is rich in alumina i.e. fly ash. The objective of this study is to experimentally investigate the properties and performance of fly ash geopolymer concrete incorporating with bamboo ash.

2. 방법론

All samples were tested through compressive strength test. In this study, the mass ratio of binder to aggregates and coarse to fine aggregate was set to be 1 and 0.45 ratio of solution to binder. The ratio for coarse to fine aggregate and sodium silicate to sodium hydroxide was set to be 1 and 2.5, respectively. Besides, Figure 1 shows the XRD analysis for both material.

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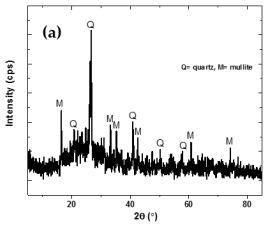

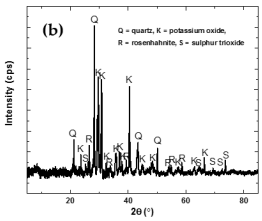

Figure 1. XRD of (a) fly ash and (b) bamboo ash

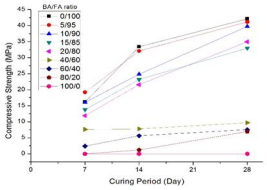

Figure 2. Effect of curing period on compressive strength of bamboo ash (BA) to fly ash (FA) ratio (%)

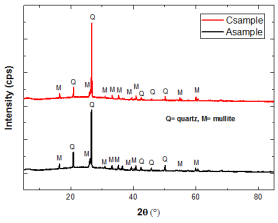

Figure 3. XRD analysis for 100% FA (Csample) and 5%BA+95%FA (Asample) after 7 days of curing

3. 결 과

All specimens were tested through compressive strength test. Figure 2 represents the effect of bamboo ash to fly ash ratio (%) on the compressive strength of geopolymer concrete. The results show that the compressive strength of geopolymer concrete is increased with the increasing of curing time. This is due to the geopolymerization process between alumina and silica from binder with the alkaline solution. However, as the percentage of bamboo ash increases, the compressive strength of geopolymer concrete is decreased. This is probably due to lack of the amount of alumina in bamboo ash which reduces the geopolymerization product and contributes to the strength of concrete. For 7 days of curing, replacement of 5% bamboo ash shows higher compressive strength which is 19 MPa compared to 100% of fly ash. The increased early age compressive strength of BA with FA can be contributed owing to the hydrolysis which impose to form crystalline phases and reduced porosity of the specimens.

To understand the formation of phases after 7 days of curing, XRD of Csample (100% FA) and Asample (5% BA+95% FA) after 7 days of curing was performed and results are shown in Figure 2. Quartz and mullite were obtained in both specimens. There is possibility that bamboo ash in Asample was completely mixed and dissolved in the matrix of fly ash attributed to the high dissolution rate of potassium oxide (K2O), rosenhahnite (Ca3Si3O8(OH2)) and sulphur trioxide (SO3) in high alkaline condition as explained by other researchers [2] during 7 days of curing. Thus, only Quartz and mullite is found as present in 100% fly ash. This result confirms that owing to the dissolution of oxides present in bamboo ash control the crack formation and fill out the porosity of geopolymer concrete resultant higher compressive strength is observed for 5%BA+95%FA (Figure 2) after 7 days of curing. The presence of quartz and mullite in Csample and Asample explained that SiO2 and Al2O3 are not fully utilized for geopolymer formation. Fly ash, bamboo ash and activator are the materials that involved in the synthesis of fly ash based geopolymer concrete incorporating with bamboo ash. The pure geopolymer network actually consists mainly Si, Al, and O with alkali Na+ or K+. In this reaction, all minerals were not participated in the geopolymerization process.

4. 결 론

5% addition of bamboo ash in 95% fly ash geopolymer concrete gave better compressive strength at early age i.e. 7 days of curing compared to control specimen.

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