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Effect of presoaking degree of lightweight aggregate on the properties of lightweight aggregate concrete

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ABSTRACT

This study aimed at exploring the effect of presoaking degree of lightweight aggregate on the fresh and hardened properties of concrete. Two series (i.e. Series A and Series B) of concrete mixes that were made of lightweight aggregate with three different moisture states were prepared. Series A mixes were developed with variable water/cement (w/c) ratio (0.50 to 0.55 by mass), whereas the w/c ratio and cement content in Series B mixes were kept constant at 0.50 and 373 kg/m^3, respectively. Slump test, mechanical tests, interfacial transition zone microscopical tests and thermal conductivity test were carried out on the specimens of different concretes and compared with control normal-weight aggregate concretes. The test results showed that the initial slump values of concrete samples of the two series mixtures were dependent on the moisture states of the aggregates. As far as Series B lightweight aggregate concrete mixtures are concerned, there was higher water/cement ratio in the early age concrete made of lightweight aggregate with longer soaking time for presoaking treatment, and thus resulting in a weak area of interface in the cement paste that leaded to higher porosity and lower compressive strength. By contrary, concrete made of lightweight aggregate without presoaking treatment achieved the highest compressive strength values at 7, 14 and 28 days.

1. INTRODUCTION

Lightweight aggregate (LWA) meets with the definition of green building materials, and thus can be regarded as a kind of ecological green building materials. Most LWA is produced from materials such as clay, shale, slate, or natural deposits and industrial wastes (Somayaji 2001, Tang et al. 2011, Tang 2014). The most important aspect of

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LWA is the porosity. The lightweight of LWA is due to the cellular or high internal porous microstructure, which gives this type of aggregate a low bulk specific gravity (Chandra and Berntsson 2002).

LWA with a variety of particle size and particle density levels has been used in the concrete industry for a variety of lightweight aggregate concrete (LWAC). Comparing with normal-weight aggregate concrete (NC), LWAC possesses many advantages such as lightweight, lower thermal conductivity, durability and better seismic resistance (Lo et al. 1999, Young et al. 2002, Holm et al. 2004, Lo et al. 2004, Lo et al. 2008, Hwang and Tran 2015, Ji et al. 2015, Oktay et al. 2015, Zhang et al. 2015). Moreover, structural LWAC slabs, walls, and beams have demonstrated greater fire endurance periods than equivalent thickness members made with NC (Holm 1994). However, owing to their cellular structure, LWAs usually absorb more water than their normal-weight aggregate counterparts. The important distinction in stockpile moisture content is that with LWA the moisture is largely absorbed into the interior of the particles, while with ordinary aggregates it is primarily surface moisture (Holm et al. 2004). In other words, LWAC can contain more evaporable water than NC owing to absorbed water in the LWA particles, which requires a modified approach to concrete proportioning. For instance, slump loss in LWAC owing to absorption can be an acute problem, which can be alleviated by presoaking the aggregate before batching. Moreover, the risk of spalling can be higher in a LWAC.

In response to the above statements, this research aims to investigate the effect of LWA presoaking on the fresh and hardened properties of LWAC. A series of experiments had been conducted, including mechanical property tests (i.e. compressive strength, elastic modulus, splitting tensile strength and flexural strength), micro property tests (i.e. microscopic hardness and pore volume content) and thermal property tests (i.e. thermal conductivity).

2. EXPERIMENTAL DETAILS

2.1 Experimental program

Two types of concretes were made: LWAC and NC, the latter serving as the reference concrete. Two series (i.e. Series A and Series B) of LWAC mixes that were made of lightweight aggregate with three different moisture states were prepared. Series A mixes were developed with variable water/cement (w/c) ratio (0.50 to 0.55 by mass), whereas the w/c ratio and cement content in Series B mixes were kept constant at 0.50 and 373 kg/m^3, respectively. Slump test, mechanical tests, interfacial transition zone microscopical tests and thermal conductivity test were carried out on the specimens of different concretes and compared with control normal-weight aggregate concretes.

2.2 Materials

The cement used here was Type I Portland cement manufactured by Taiwan Cement Corporation with a specific gravity of 3.15 and a fineness of 3400 cm^2/g. The chemical composition and physical properties of the cement are listed in Table 1. The lightweight coarse aggregate is a synthetic aggregate manufactured from fine