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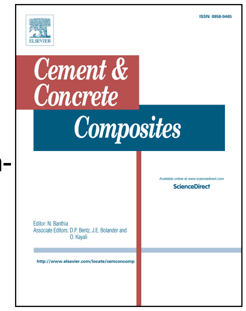

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Application of 3D-DIC to characterize the effect of aggregate size and volume on non-uniform shrinkage strain distribution in concrete

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Abstract: To elucidate the effect of aggregate size and volume on the non-uniform strain distribution in concrete, drying shrinkage of mortar and concretes were determined with 3D digital image correlation (3D-DIC). The distribution of shrinkage displacements and strains in mortar and concrete were analyzed. The results show that 3D-DIC makes it possible to measure non-uniform displacement distributions initiated by shrinkage in mortar and concrete. The non-uniformity became more remarkable with drying time. The presence of aggregates larger than 5 mm in concrete have locally changed the displacement and strain fields. Aggregates within 5-25 mm make non-uniform strain of concrete more fluctuant, especially when the aggregate size is larger than 10mm. The maximum and minimum principal strain distributions became more heterogeneous with decreasing volume of aggregates.

Keywords: 3D digital image correlation, full-field, concrete, aggregate

1. Introduction

Concrete undergoes volumetric deformation during its service life [1]. Volumetric deformation has become a common issue in structural design over the years because it is potential to increase cracking risk of concrete structures [2]. In general, volumetric deformation of concrete includes drying shrinkage, autogeneous shrinkage, carbonation shrinkage, etc. Before investigation of the concrete shrinkage, accurate shrinkage measurement of concrete is necessary. Traditionally, shrinkage of concrete can be measured by the apparatuses such as length comparator, contact strain gauge, etc. There are several standards concerned the shrinkage measurement of concrete. For example, in ASTM C157 [3], length comparator is adopted to measure the average linear shrinkage of concrete. However, these conventional methods are not able to determine the local deformation of concrete.

At the meso-level, concrete can be viewed as a type of heterogeneous material consisting of two phases (coarse aggregate and mortar). The deformation behavior of mortar is different from that of coarse aggregate. Due to the marked difference, it is believed that non-uniform deformation occurs when concrete shrinks. Non-uniform deformation is harmful to concrete structure because it may lead to cracking, which decreases the durability of concrete structures [2]. For this reason, the evaluation of the non-uniform deformation of concrete when it shrinks becomes a challenging research.

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