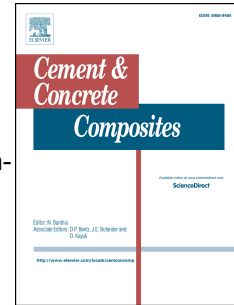


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Yang Chen, Jiangxiong Wei, Haoliang Huang, Wen Jin, Qijun Yu



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

3 Yang Chen¹, Jiangxiong Wei^{1,2,*}, Haoliang Huang^{1,2}, Wen Jin¹, Qijun Yu^{1,2}

4 1. School of Materials Science and Engineering, South China University of Technology, Guangzhou
5 510640, Guangdong, China

6 2. Guangdong Low Carbon Technologies Engineering Center for Building Materials, Guangzhou
7 510640, Guangdong, China

8
9 **Abstract:** To elucidate the effect of aggregate size and volume on the non-uniform strain
10 distribution in concrete, drying shrinkage of mortar and concretes were determined with 3D
11 digital image correlation (3D-DIC). The distribution of shrinkage displacements and strains in
12 mortar and concrete were analyzed. The results show that 3D-DIC makes it possible to
13 measure non-uniform displacement distributions initiated by shrinkage in mortar and concrete.
14 The non-uniformity became more remarkable with drying time. The presence of aggregates
15 larger than 5 mm in concrete have locally changed the displacement and strain fields.
16 Aggregates within 5-25 mm make non-uniform strain of concrete more fluctuant, especially
17 when the aggregate size is larger than 10mm. The maximum and minimum principal strain
18 distributions became more heterogeneous with decreasing volume of aggregates.

19
20 **Keywords:** 3D digital image correlation, full-field, concrete, aggregate

21
22 1. Introduction

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

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

* Corresponding author: jxwei@scut.edu.cn , Tel.: +86 20 8711 4137; Fax: +86 20 8711 4137

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