FULL-FIELD DEFORMATION MEASUREMENT SYSTEM FOR EARLY AGE CONCRETE CRACKING

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Identification of the risk of early age shrinkage cracks in fresh concrete is essential as they can lead structures to unserviceable conditions. These cracks occur when the shrinkage induced stresses exceed its tensile strength capacity of fresh concrete. In general, the risk of early age shrinkage cracks is evaluated by inspecting the tensile strain development of fresh concrete. Hence measurement of strain distribution of early age concrete is essential. However, measuring displacements and strains in fresh concrete is challenging due to its semi-solid state, which prevents the direct use of contact-based deformation measuring tools.

There were several techniques used to measure the deformations of early age concrete. Some studies have used strain gauges attached to the moulds while some measured deformations by attaching strain gauges to posts cast into the concrete. However, deformations of moulds are not the same as that of concrete and semi-solid state of fresh concrete leads to relative movements between posts and accuracy can be compromised. Recent research has processed images, taken at specific time intervals, to calculate the deformation of preidentified targets. This overcame the challenges faced with contact-based methods but suffered from poor resolution and required image corrections. With recent rapid advancements in computer processing units and camera technology, avenues are now available to use machine vision techniques such as Digital Image Correlation (DIC).

This study aims to develop an in house DIC based measurement system for evaluating full-field deformation of early-age concrete. An in-house 3D digital image correlation-based system was utilized for this purpose with a direct tensile apparatus, with modifications made to enhance accuracy. Great care was taken during the experiment procedure to distribute the speckle pattern on the semi-solid concrete surface. The modified DIC system was capable of generating full-field deformations and strain distributions of fresh concrete which is after 1 hour from casting.

The suitability of the modified system was evaluated through experimental analysis. Physical measurements were obtained using a vernier calliper and the results depict that the developed technique can measure strains with an accuracy of over 94%.

The precision of the system can be enhanced by optimizing the distribution of the speckle pattern. It is intended to utilise the developed DIC system to investigate the tensile properties of early-age concrete for different mix proportions.

Keywords: Digital image correlation, Early-age concrete, Full-field deformation, Shrinkage, Tensile properties

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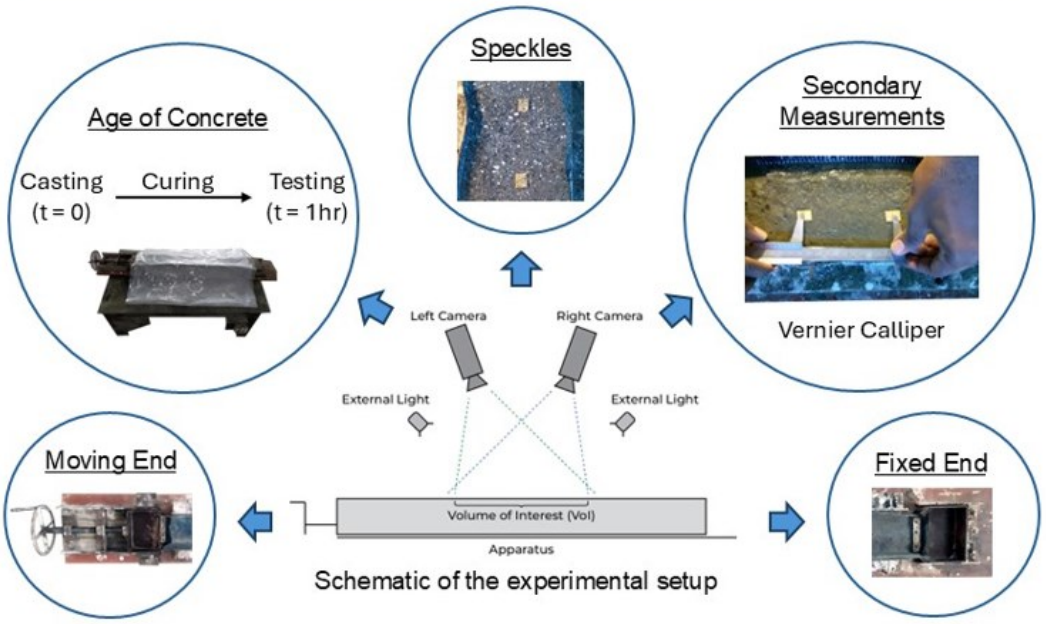
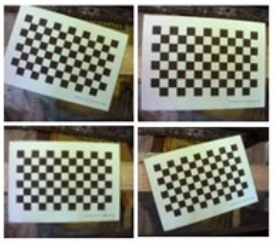


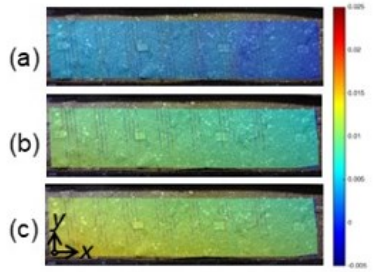
Schematic of the experimental setup



Camera calibration

Developed DIC system

x displacement (mm) of VoI after (a) 4.5 (b) 6 and (c) 7.5 mm total displacement



xx strains of VoI after (a) 4.5 (b) 6 and (c) 7.5 mm total displacement

Test apparatus