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Detecting crack profile in concrete using digital image correlation and acoustic emission

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1 Abstract

Failure process in concrete structures is usually accompanied by cracking of concrete. Understanding the cracking pattern is very important while studying the failure governing criteria of concrete. The cracking phenomenon in concrete structures is usually complex and involves many microscopic mechanisms caused by material heterogeneity. Since last many years, fracture or damage analysis by experimental examinations of the cement based composites has shown importance to evaluate the cracking and damage behavior of those heterogeneous materials with damage accumulation due to microcracks development ahead of the propagating crack tip; and energy dissipation resulted during the evolution of damage in the structure. The techniques used in those experiments may be the holographic interferometry, the dye penetration, the scanning electron microscopy, the acoustic emission etc. Those methods offer either the images of the material surface to observe micro-features of the concrete with qualitative analysis, or the black-white fringe patterns of the deformation on the specimen surface, from which it is difficult to observe profiles of the damaged materials.

1.1 Digital image correlation

Recently digital image correlation (DIC) has matured into a stable and reliable tool for fracture/damage measurement [1, 2, 3]. By contrast to the more traditional methods it is very cheap, fast and much easier to apply experimentally. The DIC technique requires minimal or no surface preparation and provides surface displacement data as the primary output. It is demonstrated that digital photo graphic images of deformed solids could be analyzed to estimate the in-plane displacements of various points on the surface. In this study, a commercial software Vic2D for digital image correlation is used to measure the displacement field in the cracking area. Using the displacement field data, crack opening at various locations of crack is measured. The location of the crack tip is estimated using the crack opening data and also from Sobel crack detection algorithm.

1.2 Acoustic emission technique

Acoustic emissions (AEs) are the stress waves produced by the sudden internal stress distribution of the materials caused by the changes in the internal structure. Possible causes of the internal structure changes are the crack initiation and growth, crack opening and closure or dislocation movement. Most of the studies have focused on relating acoustic emission characteristics to the properties of the fracture process zone and using AE source location analysis to evaluate damage localization and the

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overall damage study [3]. In this paper, AE technique is applied to locate the damage zone ahead of the crack tip. The primary aim is to identify the size of zone of microcracking ahead of the propagating crack. In this study, AE technique is applied simultaneously with digital image correlation. It is observed that the two techniques in coupled position proved quite effective in identifying the fracture process zone and cracking mechanism of concrete.

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