Crack monitoring by fibre optics and image correlation: a pilot study

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Abstract

As reinforced concrete structures reach the end of their design lives, technology for improving accuracy and efficiency of inspections and structural health monitoring rapidly progresses. Concrete cracking and reinforcement strains are two relevant parameters in assessing damage and safety of these structures. The use of Digital Image Correlation (DIC) systems and distributed Fibre Optic Sensors (FOS) to evaluate these parameters are two of the technologies that have been gaining momentum due to their advantages over other approaches. This study presents an experimental investigation of crack propagation of a reinforced concrete beam specimen through FOS and DIC. The FOS were positioned inside a groove carved in the rebar and in the concrete immediately outside the bar for comparison. The results showed a significant difference between both positions, with more reliable data coming from inside the bar. The addition of the DIC crack propagation images to the FOS analysis complemented the results, and good visual correlation was identified between both methods. This study is part of a broader research program, which aims at applying DIC and FOS for structural health monitoring of a real scale bridge structure.

Keywords: reinforced concrete; Fibre Optic Sensors; Digital Image Correlation; crack propagation.

1 Introduction

Many reinforced concrete structures built around the world are close to reaching the end of their service lives. Rehabilitation of infrastructure that has been deemed unsafe is very costly, both financially and environmentally. As deterioration of critical infrastructure is a growing concern, technology to identify and monitor damage has been advancing rapidly to improve assessment of these structures. This study is part of a broader research, which targets improvement of bridge inspection and assessment through technology such as Digital Image Correlation (DIC) and Digital Twins (DT).

DIC is a non-contact measurement technique that uses digital images to obtain surface displacement and deformation. Concrete cracking is a common degradation indicator for reinforced concrete structures, so the evaluation of this parameter is usually critical during inspections. In visual inspections, this evaluation is highly time-consuming and subjective. Conversely, the interest in image-based crack detection, such as DIC, is increasingly growing, due to its rapidity of implementation and convenience [1].

In addition to concrete cracks, the analysis of reinforcement strain, especially tensile strain, is particularly important in evaluating safety of structures. Reinforcement strain is at its highest at the location of cracks, which is not easily predicted