Subsurface defect detection in concretes by active infrared thermography

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Abstract

This paper presents observations from an active infrared thermography (IRT) experiment about structural monitoring by taking advantage from solar irradiance as a clean and renewable source of energy for thermal excitation. This contributes to reduction of carbon emissions associated with maintenance of existing concrete infrastructure and ensuring their extended life, and safe operation. The models in these observations were five concrete slabs made from a typical mix used for bridge construction in the UK, with simulated subsurface void (representing the defect) at depths of 5 to 25 mm (5mm increment) at the centre of slabs, and one slab without simulated defect. This study was conducted during a sunny afternoon. A sequence of IR images was collected for each slab (six sequences in total), and these sequences were used to calculate the average thermal contrast on surface of the slabs and evaluate its variation with depth of subsurface defect. Finally, the trend of thermal contrast is compared with the trend of thermal contrast from excitation by IR heater to highlight the limitations and future research needs for subsurface damage detection using solar irradiance.

Keywords: Infrared thermography (IRT), Damage detection, Concrete infrastructure, Non-destructive testing (NDT), Structural health monitoring (SHM), Carbon reduction.

1 Introduction

The 26th United Nations Climate Change Conference (COP26) in Glasgow, stimulated collective action and commitments to tackle climate change. Among the goals for the summit were to assure global net-zero by 2050, keep 1.5 degrees within reach, mobilise finance and adapt to protect communities and natural habitats [1]. This means that the world should reduce the global emissions of greenhouse gases as close as possible to zero so that the natural carbon sinks such as forests and carbon capture technologies can absorb the rest of emissions [2].

UK is legally committed to reduction of 80 percent of carbon emissions by 2050 and emissions should be halved during 2023 to 2027 carbon budget period. The infrastructure sector is responsible for one sixth of the emissions and therefore must play its role to reach the net-zero goal. Thus, carbon reduction should be cultivated in the DNA of infrastructure. Infrastructure industry can control reduction in capital carbon (emissions associated with production of an asset) and operational carbon (emissions associated with operation and maintenance of an asset)[3]. Manufacturing and construction sector in the UK was responsible for