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Subsurface defect detection in first layer of pavement structure and reinforced civil engineering structure by FRP bonding using active infrared thermography

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In many countries road network ages while road traffic and maintenance costs increase. Nowadays, thousand and thousand kilometers of roads are each year submitted to surface distress survey. They generally lean on pavement surface imaging measurement techniques, mainly in the visible spectrum, coupled with visual inspection or image processing detection of emergent distresses. Nevertheless, optimisation of maintenance works and costs requires an early detection of defects within the pavement structure when they still are hidden from surface. Accordingly, alternative measurement techniques for pavement monitoring are currently under investigation (seismic methods, step frequency radar).
On the other hand, strengthening or retrofitting of reinforced concrete structures by externally bonded Fiber Reinforced Polymer (FRP) systems is now a commonly accepted and widespread technique. However, the use of bonding techniques always implies following rigorous installing procedures. To ensure the durability and long-term performance of the FRP reinforcements, conformance checking through an in situ auscultation of the bonded FRP systems is then highly suitable. The quality-control program should involve a set of adequate inspections and tests. Visual inspection and acoustic sounding (hammer tap) are commonly used to detect delaminations (disbonds) but are unable to provide sufficient information about the depth (in case of multilayered composite) and width of debonded areas. Consequently, rapid and efficient inspection methods are also required.
Among the non destructive methods under study, active infrared thermography was investigated both for pavement and civil engineering structures through experiments in laboratory and numerical simulations, because of its ability to be also used on field.
Pulse Thermography (PT), Pulse Phase Thermography (PPT) and Principal Component Thermography (PCT) approaches have been tested onto pavement samples and CFRP bonding on concrete samples in laboratory. In parallel numerical simulations have been used to generate a set of time sequence of thermal maps for simulated samples with and without subsurface defect. Using this set of experimental and simulated data different approaches (thermal contrast, FFT analysis, polynomial interpolation, singular value decomposition...) for defect location have been studied and compared. Defect depth retrieval was also studied on such data using different thermal model coupled to a direct or an inverse approach. Trials were conducted both with an uncooled and cooled infrared camera with different measurement performances. Results obtained will be discussed and analysed in the paper we plan to present. Finally, combining numerical simulations and experiments allows us discussing on the sensitivity influence of the infrared camera used to detect subsurface defects.