Benefits of using digital image correlation systems for advanced structural assessment

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Abstract

New developments in civil engineering in the area of innovative high-performance materials and sophisticated geometrical designs generate the need for advanced measurement and monitoring systems. Based on years of utilizing digital image correlation (DIC) in a diverse field of applications, the advantages and disadvantages of DIC measurements are highlighted, by means of a selection of various experimental tests conducted by the authors. Recommendations for a general methodology for the utilization of DIC systems are presented. For this purpose, the beneficial advantages in the case of a variety of different chosen test setups, as well as the originated evaluation data, are shown. Such a type of non invasive optical measurement system enables the user to gather data even in challenging conditions, where a brittle failure of the specimen has to be expected and conventional measurement equipment, like LVDTs or displacement transducers, reach their limit. In addition, a simplified model for a 3D measurement setup calculation is presented.

Keywords: Digital image correlation, DIC, monitoring, concrete structures, UHPC, fibers, CFRP strengthening

1 Introduction

Technological advances in the field of computer technology and optical precision sensors in the past years made it possible to establish digital image correlation as a useful tool for structural monitoring. Over the past years, this technology has been increasingly adopted by the scientific community in a wide variety of fields, from monitoring of large-scale structures to regular use in small-scale testing and material characterization. Still, DIC has not yet found its way into recommendations in guidelines for material and structural testing. This is mainly caused by a large range of different technical solutions on the market and a non-unified handling of the preparation of the specimen, the test setup itself, and the available evaluation software from the side of the scientific community. The following work shall highlight the possibilities of this measurement technique, and summarize experiences and recommendations gained over the past years through a selection of fitting case studies from conducted laboratory tests.

2 Digital image correlation – the principle

Digital image correlation serves as a non-contact strain and deformation measurement solution for materials and product testing. Using high-resolution cameras, a series of pictures of the specimen's surface are taken during the tests. A dedicated software is then able to compare such pictures and, by detecting the change in the grayscale value between a reference and the analyzed image, calculate the deformation with very high accuracy. For this reason, it is important to prepare the surface of the specimen ensuring

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