A Comparison Between the Accuracy of Two-Dimensional and Three-Dimensional Strain Measurements

This investigation determined the effect of specimen out-of-plane movement on the accuracy of strain measurement made applying two-dimensional (2D) and three-dimensional (3D) measurement approaches using the representative, state-of-the-art digital image correlation (DIC)-based tool ARAMIS. DIC techniques can be used in structural health monitoring (SHM) by measuring structural strains and correlating them to structural damage. This study was motivated by initially undetected damage at low strains in connections of a real-world bridge, whose detection would have prevented its propagation, resulting in lower repair costs. This study builds upon an initial investigation that concluded that out-of-plane specimen movement results in noise in DIC-based strain measurements. The effect of specimen out-of-plane displacement on the accuracy of strain measurements using the 2D and 3D measurement techniques was determined over a range of strain values and specimen out-of-plane displacements. Based upon the results of this study, the 2D system could measure strains as camera focus was being lost, and the effect of the loss of focus became apparent at 1.0 mm beam out-of-plane displacement while measuring strain of the order of magnitude of approximately 0.12%. The corresponding results for the 3D system demonstrate that the beam out-of-plane displacement begins to affect the accuracy of the strain measurements at approximately 0.025% strain for all magnitudes of out-of-plane displacement, and the 3D ARAMIS system can make accurate strain measurements at up to 2.5 mm amplitude at this strain. Finally, based upon the magnitudes of strain and out-of-plane displacement amplitudes that typically occur in real steel bridges, it is advisable to use the 3D system for SHM of stiff structures instead of the 2D system.