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The technique of digital image correlation to identify defects in glass structures

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SUMMARY

The article describes an experiment using the technique of digital image correlation (DIC) to identify and analyse defects in glass structures. The investigation involved three sets of glass structures, that is, float glass sheets, with or without any defects and subjected to bearing tests. The DIC technique perfectly identified not only the position and size of the defect but also the magnitude of deformations around the defect itself. Low stress values also indicate that strains concentrate around the defects. This enables the DIC method to be used to investigate the quality of glass elements, to detect the presence of defects and to monitor the most critical structural elements. The results obtained with the DIC technique were confirmed by comparing them with data gathered from the analysis of the fracture surface. Copyright © 2014 John Wiley & Sons, Ltd.

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KEY WORDS: digital image correlation; DIC technique; defects; glass structures; fracture surface

1. INTRODUCTION

In the field of large glass structures, the formation of cracks has been studied in great detail, as this is a sudden, uncontrollable phenomenon, influenced by the hygrometric conditions of the environment. It depends on micro-defects on the surface of the glass as a result of inclusions in the glass thickness or to scratches caused by the moulding process or by damage to the edges of the sheets during use or during the finishing and cutting process. As there is no plastic strain prior to the fracture, the concentration of stresses at the apex of the defect cannot be redistributed on the remaining part of the specimen. As the load increases, the fracture occurs without prior warning. Furthermore, the amorphous structure of glass means it has no resource of its own to prevent the catastrophic propagation of a crack that has become unstable, as a result of the critical combination of two factors, such as the length of the crack itself and the magnitude of the tensile stresses around the edge. This is the opposite effect to what takes place when the lattice in crystalline metals is modified or when micro-cracks form in concrete mixes.

The models of tensile strength of glass present in scientific literature [1–3] agree that tensile breaking strength is associated with the propagation of a pre-existing micro-crack, a propagation that appears to be influenced by the length of time of application of the load. More recent studies have shown there is a limit to the factor of intensification of the stresses in the fissure, below which the fissure does not expand [4].

In order to study this phenomenon, it is of particular interest to identify the micro-defects and assess their influence on glass resistance. In this respect, some experiments have been carried out to verify how far glass resistance depends on the manufacturing and processing procedures. In particular, we

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