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INTEGRITY RELIABILITY AND FAILURE CHALLENGES AND OPPORTUNITIES

Editors:

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PREFACE

As the engineering community continues to cross the boundaries of known practices, materials and manufacturing techniques into the frontiers of new functional materials, environments and applications, the opportunities for catastrophic failures will inevitably increase. If our knowledge of how to engineer systems, structures and components to minimize or prevent catastrophic failure is to keep pace with modern manufacturing technologies, the demanding applications, and the intolerance of a safety conscious society, we must continue our efforts to develop and use superior materials, apply reliable analytical techniques and validate these with sound experimental tools.

The objective of this gathering is to provide a forum for the discussion and dissemination of recent advances in three related areas: integrity, reliability and failure of engineering structures, components and systems. The goal is to enable mechanical, aeronautical, civil, automotive, biomedical and nuclear engineers, researchers and scientists from all over the world to exchange ideas on mechanics, materials and design as they relate to system integrity and reliability.

This third international conference was part of a prestigious series of Integrity Reliability and Failure conferences coordinated by the International Scientific Committee on Mechanics and Materials in Design. The conference attracted over 260 participants with 310 accepted academic and industrial submissions from 45 different countries around the world. These papers were presented in July 20–24, 2009 in the magnificent city of Porto, Portugal, and the conference themes focused on design, nanotechnology, computational and structural mechanics, experimental mechanics, advanced materials, energetic systems, and case studies.

We are particularly indebted to the *Symposium Promoters* for the coordination of the different themes and to the authors for their papers and oral presentations. Each of the more than 300 oral contributions offered opportunities for thorough discussions with the authors. We acknowledge all of the participants, who contributed with innovations, new research approaches, novel modelling and simulation efforts, and invaluable critical comments.

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DISPLACEMENT FULL-FIELD MEASUREMENT AT CRACK ROOT USING THE INTERFEROMETRIC MOIRÉ TECHNIQUE

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SYNOPSIS

The weight is a preponderant factor in the transports industry, where is demand a superior performance to the metals structures. These elements are subject to high stresses and work near to the limit of the material yield strength, with high safety requirements. The presence of small cracks can conduce at long term to the structure failure. Therefore, a prediction model of crack propagation must be developed based on the analysis of the displacement field near the crack root (Kang, 2001). Moiré interferometry technique (Post, 1994) is suitable for full-field non-contact and with high resolution measurements of the in-plane displacements (Ribeiro, 2008). More recently, interferometric Shearography technique was introduced for the measurement of the gradient displacement field (Lopes, 2007). For small displacements, the second order of the gradient can be neglected, allowing the direct measurement of in-plane strain fields. The improvement of spatial resolution and the quality are achieved by numerically post-processing the experimental data. These involved the use of dedicated image processing techniques (Lopes, 2008) for the application of temporal phase technique (Creath, 1996), filtering the high frequency noise, elimination of the phase discontinuities and extracting the full-field strain fields. The main objective of this paper is to show the advantages of using the interferometric techniques in the measurement of global displacements and strain fields in the root of a crack. The evaluation of experimental measurements is performed by comparing the results with the numerical simulation.

RESULTS

A test specimen with a 7 mm crack was studied using Moiré (Ribeiro, 2006) and the Shearography interferometry techniques. The experimental assessment of global behavior in the crack root was performed using the 3 points bending test according to the ASTM E399-90 standard test (ASTM, 1992), presented in Figure 1.

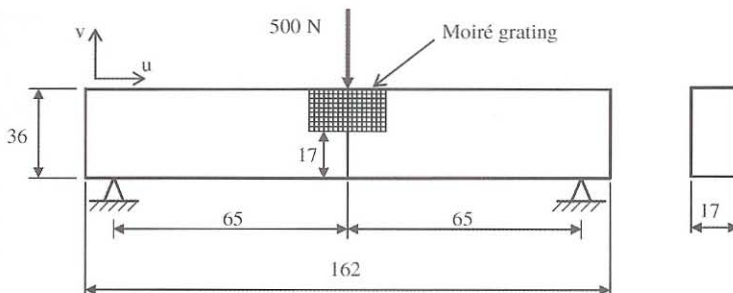


Fig. 1 The experiment set-up based on ASTM E399-90 standard test (dimensions in millimetres).

The displacement fields in two orthogonal directions (u , v) are measured with Moiré interferometry technique and presented in the Figure 2.

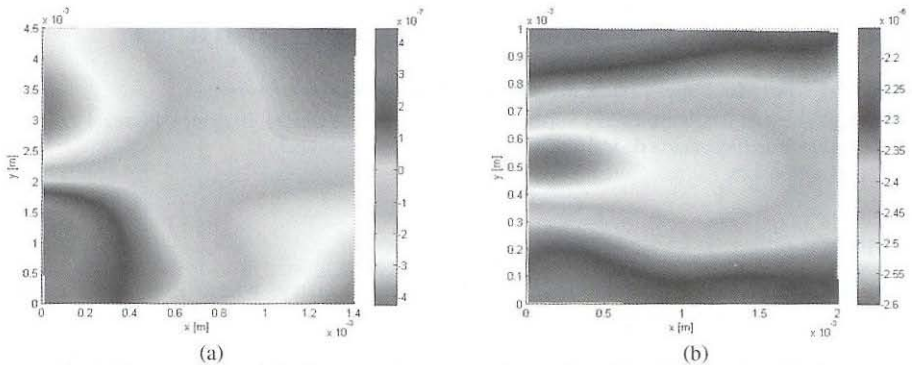


Fig. 2 The experimental displacement fields in crack root for: a) u direction; b) v direction.

CONCLUSIONS

The two interferometric techniques used in this work show to be well adapted for the non-contact, full-field measurement of the displacement and strain fields in the crack root. A good correlation was obtained between the experimental measurements and the numerical simulation, despite of small local differences as result of the deviation of the loading vector. The direct measurement of gradient of displacement field with the shearography technique proved to be an alternative option to the electric strain gages, although the poor quality of the results. Better results are expected in the future by improving the two illumination vector adjustment.

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