RECENT ADVANCES IN
INTEGRITY-RELIABILITY-FAILURE

J.F. Silva Gomes, Shaker A. Meguid
Editors

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EDITORS 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. It is with this in mind that this series of conferences was organised.

The objectives of this gathering are to provide a forum for the discussion and dissemination of recent advances in assessing the integrity, reliability and failure of engineering structures, components, and assemblies, foster research in these areas, and promote international co-operation among scientists and engineers in the field. The goal is to enable concerned 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 fourth international conference, which is sponsored by the University of Porto, the University of Toronto and the University of Madeira, is 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 300 participants with 380 accepted submissions from 45 different countries around the world. These papers were presented in June 23-27, 2013 in the magnificent city of Funchal, Madeira. The conference themes which address integrity, reliability and failure focused on Analytical and Numerical tools, Testing and Diagnostics, Surface and Interface Engineering, Sensors and Instrumentation, Tribology, Mechanical Design and Prototyping, Modes of Failure, Composite Materials, Nanotechnologies and Nanomaterials, Biomechanics, Energy and Thermo-Fluid Systems, Impact and Crashworthiness and Case Studies.

We are particularly indebted to the authors and special guests for their plenary lectures and presentations. Each of the more than 380 contributions offered opportunities for thorough discussions with the authors. We acknowledge all of the participants, who contributed with innovations, new research approaches, novel modeling and simulation efforts, and invaluable critical comments. We are also indebted to the outstanding plenary lecturers who highlighted the conference themes with their contributions: Professor Xiong Zhang (Tsinghua University, P. R. China), Professor E.A. Elsayed (Rutgers University, USA) and Professor Noritsugu Umehra (Nagoya University, Japan). We also take this opportunity to thank the members of the International Scientific Committee and reviewers for their time and effort.

Last but by no means least, we offer our sincere gratitude to the symposia organisers for their contribution to the success of the event and the local organising committee for attending to many aspects of the conference demands. For all of them, we are truly very grateful.

Shaker A. Meguid and J.F. Silva Gomes
Funchal / Madeira, June 2013

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APAET-Portuguese Association for Experimental Mechanics
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A. KEYNOTE PAPERS

PAPER REF: 4036

DISPLACEMENT AND STRAIN FULL-FIELD MEASUREMENT AT OPEN HOLE COMPOSITE SPECIMEN USING THE DIGITAL IMAGE CORRELATION TECHNIQUE

João Ribeiro[1(*)], Hernani Lopes[1], Soraia Pimenta[2], Mário Vaz[3]
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ABSTRACT

This work presents the analysis of the displacement and strain fields at open hole carbon epoxy composite specimen using the optical of Digital Image Correlation (DIC). An uniaxial tensile test with Hexcel IM7/8552 composite specimen that was previous drilled and created a random intensity pattern on its surface. During the test was captured a sequence of images using an equipment of commercial DIC system, the Aramis®. The results were subsequently analyzed and was verified the possibility of damage detection using this technique.

Keywords: digital image correlation, composites, full-field techniques, damage detection.

INTRODUCTION

The increase in energy prices has led to the development of new materials which the weight is a preponderant factor, mainly in the transports industry, where there is demanded for a superior performance to the structural elements. These elements are subject to high stresses and work near to the limit of the material strength, with high safety requirements. The new generation of composites materials can provide the mechanical properties required by the most demanding industries. However, the behavior of these new materials with stresses concentration is not totally known and, thereby, must be analyzed using experimental techniques (Launay, 2008) and numerical tools (Alfano, 2001).

The aim of this work is to present the advantages of using the Digital Image Correlation in the measurement of full-filed displacements and strain fields in composite plates with concentration stresses. The evaluation of experimental measurements is performed by comparing the results with the numerical simulation.

RESULTS AND CONCLUSIONS

The Fig. 1 shows the curve of remote stress in time obtained from tensile test. During the test, a camera of Digital Image Correlation system has captured the sequence of images, with a rate 40/100, which were used to compute the full displacements and strain fields. In Fig. 2 is represented the displacement and strain fields in the y direction for the t=90s. For this instant it is possible to observe that the maximum displacement value is 3.88 mm and the maximum strain value is 1.46 [mm/mm].

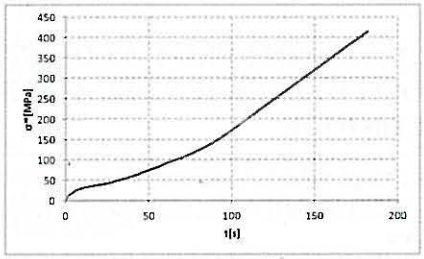
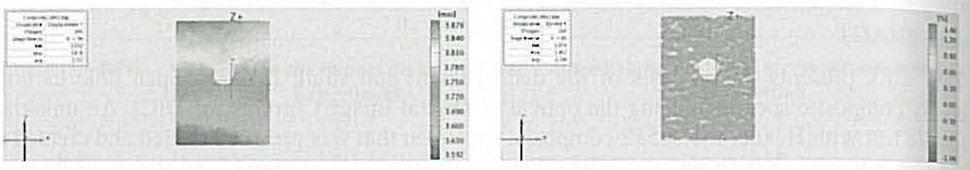


Fig. 1 - Remote stress versus time.



(a) (b)

Fig. 2 - Displacement (a) and strain (b) fields for the 90th second in y direction.

The comparative analysis shows that there is a good agreement between the measure displacements field and the numerical simulation at the hole edge. The experimental results show that Digital Image Correlation is a suitable full-field experimental technique for the measurement of the displacement field in composite materials, especially for large deformations. However, presents low sensitivity for the measurement of strain field, as result, shows a low signal-to-noise ratio, making difficult the analysis of strain field, even at the edge of the hole.

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