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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SEM-American Society for Experimental Mechanics
BSSM-British Society for Strain Measurement
JSME-Japanese Society of Mechanical Engineering
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AFM-Association Française de Mécanique
DYMAT-European Association for Dynamics of Materials
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A. KEYNOTE PAPERS

PAPER REF: 4683

FBG SENSORS APLICATION FOR RESIDUAL STRESS MEASUREMENT USING THE HOLE DRILLING METHOD

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ABSTRACT

This work focus on the development of a new sensor for residual stress measurement using fiber optic Bragg sensors. A known stress field was induced on a specimen and results obtained from both the fiber optic Bragg sensors rosette and traditional electrical strain rosette were compared. Also a FEM model was used to confirm the obtained results.

Keywords: residual stress, hole drilling, FBG sensor.

INTRODUCTION

Weight and cost reduction policies have increased the pressure to better understand the effect of residual stresses on the mechanical properties of components/structures. Several failure mechanisms can be exacerbated by the presence of locked-in residual stresses. In most cases, residual stresses are created due to mechanically induced plasticity or by thermal effects (Withers & Bhadeshia, 2001) Quantitative estimation of residual stresses is important for a safe performance of structural components (Venkitakrishnana, et al., 2007).

Hole drilling is a widely accepted technique for residual stress measurement, existing already an ASTM standard regarding the technique (ASTM, 2008). This method, involves drilling a small hole into the surface of a component at the centre of a special strain gage rosette and measuring the relieved strains. This type of sensor can be problematic when used on industrial environments, mainly due to electrical noise and magnetic fields. In order to eliminate this drawback, this study is focused on the development of a new methodology to replace the electrical sensors with fiber optic sensors, fiber Bragg grating (FBG) sensors. After installation and residual stress measurements, this new type of sensors can also be used to monitor the strain loading of the component during service.

RESULTS AND CONCLUSIONS

A four point bending system (see Figure 1) was specially made in order to induce a consistent stress field in AA7075-T73 aluminium alloy specimens. Electrical strain gauge rosettes and fiber optic rosette measurements were compared. Figure 2 shows an example of principal stresses for the electrical strain gauge rosette.

A finite element method (FEM) model (see Figure 3) containing 547840 C3D8R elements was analyzed using Abaqus, and the obtained stresses were then compared to the experimental results.

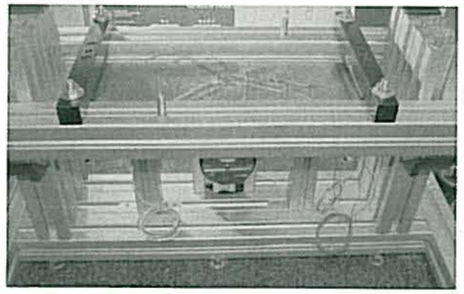

Fig. 1 - Four point bending system

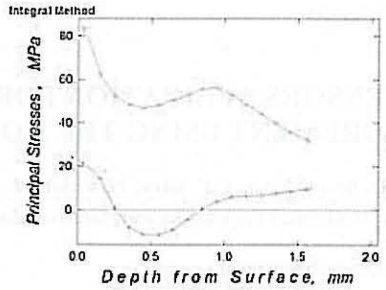

Fig. 2 - Example of results for principal stresses distribution measured using an electrical strain gauge rosette

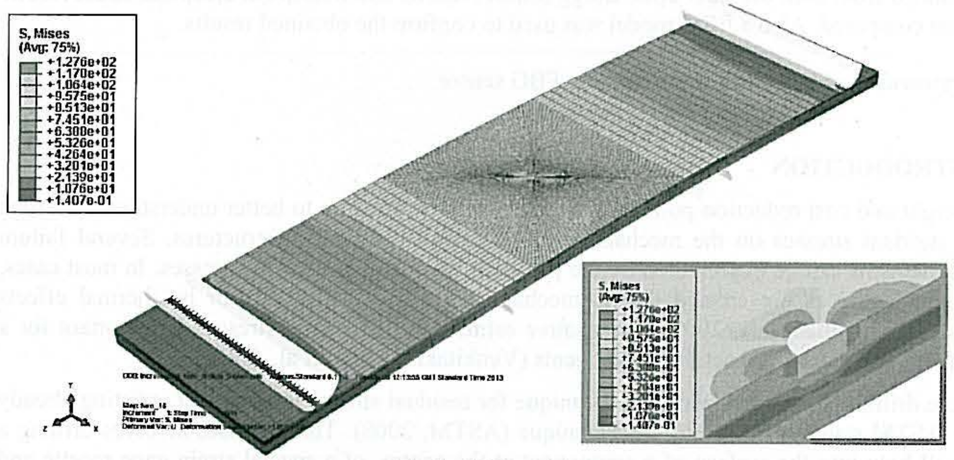

Fig. 3 - FEM model

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PAPER REF: 4107

TIME TO FAILURE OF BEND INSNSITIVE OPTICAL FIBER UNDER SMALL BEND DIAMETERS

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ABSTRACT

In this work, we investigate the time to failure of optical fiber submitted to small bending diameters during under service test. The bending diameters under study were 2.9, 3.1 and 3.3 mm for an optical power of 5.5mW.

Keywords: optical fiber, FTTH, small bend diameters, time to failure.

INTRODUCTION

The massive use of fiber optics in residential environments, Fiber To The Home (FTTH) scenario, has triggered new concerns regarding the optical fiber performance and reliability, including the additional attenuation imposed by the fiber bending during the deploy and its degradation over time. To overcame and/or smooth these problems new types of fibers have been tested for the FTTH implementation, namely the bend insensitive (BI) optical fibers. This fiber offers an improved sensitivity to the small diameters, but there is a lack of information regarding the limit conditions they would be able to stand and how would they respond in such situations. Some tests regarding this subject were already made (Griffioen, 2009), nevertheless they take into account the physical response of the fiber and its behavior/ reliability, without consider the added degradation induced by the leakage of the optical power in the small bends. In the bended regions of the optical fiber, part of the optical power propagating, irradiates to the cladding and coating surrounding the core (André, 2010)-(Rocha, 2009). This leakage of optical power induces an accelerated degradation of the fiber, which may be responsible for the fracture of the fiber. Also for high power situations, the physical destruction of the fiber can be witnessed as the fiber fuse effect triggered (André, 2010), (Rocha, 2011).

In this work, we analyze the time to failure of a Bend Insensitive single mode optical fiber (Fujikura, FutureGuide®-SR15E), when submitted to a small bend diameter, 1.80, 2.40 mm and 3.45 mm, under a constant optical signal exposition. The optical signal (OSICS-TLS) injected in the fiber under test, had an optical power of 5.5mW, with a wavelength of 1567 nm. The fiber was placed in a kink loop, which is considered as the worst case situation (Griffioen, 2009).

The output fiber optical signal was continuously monitored, through a power meter (HP, 81531A Power Sensor, 800-1700 nm), until the rupture of the fiber. This monitoring was made at the same time for the several fibers under test.