

MECHANICS AND MATERIALS IN DESIGN

Edited by

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&
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PREFACE

M²D'2006 is the fifth international gathering of scientists and engineers interested in the fields of engineering mechanics, design and materials engineering planned for July 24-26, 2006 in the beautiful city of Porto, Portugal. This is a well-established meeting with followers from some 35 nations.

The first conference of this series was held in Toronto in 1996 and attracted over 150 delegates. The second was organized by Professors J.B. Hull and R. Gentle in Nottingham in 1998. The third was organized by Professor S.A. Meguid in Orlando in 2000. The fourth was organized by Dr. T. Mori and Professor H. Fujii in Nagoya, Japan in June 2002. These meetings resulted from the belief that of those disciplines associated with advanced product design and manufacture, engineering mechanics and materials engineering have made the most significant advance in recent years. Important and dramatic improvements in component design can be made by the use of the latest advances in mechanics and materials. Indeed, as a result of the activities in these three important fields: Mechanics, Materials and Design, the International Journal of Mechanics and Materials in Design was established in 2004. With Professor J.F. Silva Gomes being an important member of the Editorial Board and Professor Shaker A. Meguid being its Editor-in-Chief.

It is with this in mind that this *Fifth International Conference on Mechanics and Materials in Design* is organized. The purpose is to bring together scientists and engineers from the mechanics and materials communities to present their latest results and discuss new advances over a broad range of topics dealing with analytical, numerical and experimental techniques in mechanics and advances in materials' technology as well as case studies. We have done our best to provide the delegates with an environment conducive to exchange of knowledge, networking and making new friends.

We take this to thank our colleagues who contributed considerably to the event by organizing topical symposia and by helping us to launch this important meeting. We are truly grateful for their efforts. We also wish our overseas friends to have a great time in Portugal. We wish you all a happy and successful stay in Porto.

Shaker A. Meguid

J.F. Silva Gomes

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RESIDUAL STRESS ASSESSMENT USING OPTICAL TECHNIQUES

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SYNOPSIS

The goal of this work is the development of experimental techniques to measure residual stresses as alternative to the hole-drilling method. The techniques here proposed are based on the use of Moiré Interferometry and Electronic Speckle Pattern Interferometry (ESPI). They are field techniques that allow in-plane displacements measurement without contact and with high resolution. Grating replication techniques were developed to record high quality diffraction gratings onto the specimen's surfaces. The developed an optical set-up to generate the master gratings (virtual) is also discussed. In this case an in-plane interferometer to measure displacements in two directions was implemented as well as a drilling equipment to provoke the stress relaxation in the specimens. During residual stresses measurements the obtained fringe patterns (Moiré and speckle) are video recorded. Image processing techniques are used to assess the in-plane strain field. A finite elements code (ANSYS®) is used to simulate the process of relaxation of stresses to compare with experimental results and to calculate the hole-drilling calibration constants.

INTRODUCTION

In this work, we developed an experimental process to measure residual stresses with two optical techniques (in-plane ESPI and Moiré Interferometry) combined with the hole-drilling method. A ring and plug specimen with known residual stress distribution was used to validate the techniques. An aluminium ring and a plug with 0.08 mm of diametrical interference between them were assembled for that purpose. A numerical simulation with finite elements, using the ANSYS® programme, was developed to compute the calibration coefficients needed to obtain the stress values.

The first test was performed using the in-plane ESPI set-up. Several holes with different diameters and depths were drilled in both ring and plug. Image processing algorithms were used to obtain the displacement field from the interferometric recordings. The second test was done with Moiré Interferometry. For that a 1200 l/mm grating (x and y crosses gratings) was replicated on the specimen surface. An optical set up to measure in two directions was used to assess the radial and circumferential stress released by several holes drilled in different radial distances from the centre of the specimen.

RESULTS

For the ESPI technique the phase maps of the interferometric patterns were calculated using temporal phase shift. When drills are made a strain relaxation occurs and the ESPI system measures the difference between the two stages, before and after the drilling. The obtained

phase maps are similar to the one presented in Figure 1(a). In Figure 1(b) it is possible to see the displacement field after image processing. In this case the stress values were codified in a false colour table.



Fig.1 Example of a Phase map obtained after stress relaxation (a) and displacement field of stress relaxation after image processing (b).

The results obtained after a set of measurements in the specimen used to validate the technique are presented in Figure 2

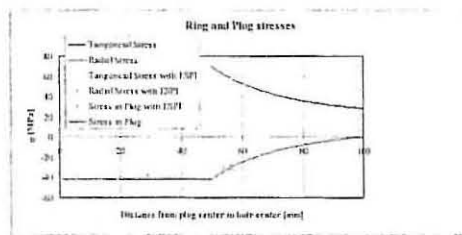


Fig.2 Comparison between analytical calculations and experimental measurements with ESPI.

CONCLUSIONS

The experimental results that were measured with ESPI have a good agreement with the analytical calculations. This optical technique is a very interesting alternative to the traditional hole-drilling method with strain gages and with the advantage that is possible to measure displacement fields instead of the discrete measurements obtained with the traditional methods based on the use of strain gages.

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