

PROCEEDINGS ICEM15

15th International Conference on Experimental Mechanics

FEUP - EURASEM - APAET

Porto, 22-27 July 2012

Editors

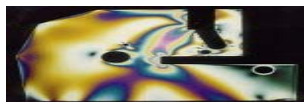
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Home ●

Editors Preface ●

Keynotes & Papers ●

Authors Index ●

Organisation ●

Participants ●

Program ●

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Editors Preface

Engineering practice in general and mechanical design in particular are basically exercises of creativity, triggered by specific needs. As the engineering community continues to cross the boundaries of known practices, design and manufacturing techniques into the frontiers of new materials and mechanical systems, energy sources and their effects upon the environment, the opportunities for failure will inevitably increase. If our knowledge of how to engineer systems, structures and components to minimize or prevent failure is to keep pace with modern demanding applications and the intolerance of a safety conscious society, we must develop and apply superior analytical and experimental tools to evaluate the potential for damage or failure of engineering structures and/or components and the associated energy harvesting systems.

Different tools are available to optimize any engineering solution, from which *Experimental Mechanics* has always played a most prominent role. It is related to such diverse disciplines as physical and mechanical sciences, engineering (mechanical, aeronautical, civil, automotive, nuclear, etc.), materials, electronics, medicine and biology, and uses experimental methodologies to test and evaluate the behaviour and performance of all kinds of materials, structures and mechanical systems. Quality control, safety, destructive and non-destructive testing of materials and components, analysis of prototypes and even fundamental research are some of the possible applications of *Experimental Mechanics*. During the last few decades the development of computer based techniques, as well as laser-optics methods, nanotechnologies and nanomaterials, among many other technological advances, added new dimensions and perspectives to *Experimental Mechanics and Testing*.

This CD-ROM contains the 566 papers accepted for presentation in the ICEM15-15th International Conference on Experimental Mechanics held in Porto/Portugal, 22-27 July 2012. The different papers are organized in three main parts: PART-A, with the files of the 11 Invited Plenary Papers, by distinguished academics and scientists in the field of *Experimental Mechanics*; PART-B, with 289 papers distributed by the 12 general tracks/main topics (from A to L); and PART-C, with the remaining 266 papers from the 20 Special Symposia in ICEM15.

The ICEM15 conference is part of a prestigious series of conferences that was initiated in 1959, in Delft (The Netherlands), and the last one took place in Poitiers (France) in July 2010. All these *Experimental Mechanics* meetings resulted from the belief that of those disciplines associated with advanced product design and manufacture, experimental mechanics techniques have been making continuous and significant advances during the years. Important and dramatic improvements in systems and components design can be made by the use of the latest advances in experimental mechanics techniques applied to energy systems, structures and materials. Their effect on the environment is significant and will help in avoiding global warming and harmful CO₂ emissions.

It is organized by the Faculty of Engineering of the University of Porto (FEUP) and the Portuguese Association for Experimental Mechanics (APAET), under the auspices of the European Society for Experimental Mechanics (EURASEM), and sponsored by a number of national and international organizations, whose support is gratefully acknowledged: SEM-American Society for Experimental Mechanics, BSSM-British Society for Strain Measurement, JSME-Japanese Society of Mechanical Engineering, IMEKO-International Measurement Confederation, AFM-Association Française de Mécanique, DYMAT-European Association for Dynamics of Materials, INEGI-Instituto de Engenharia Mecânica e Gestão Industrial, LABIOMEP-Laboratório de Biomecânica do Porto, LNEC-Laboratório Nacional de Engenharia Civil, FCT-Fundação para a Ciência e a Tecnologia, FCG-Fundação Calouste Gulbenkian, FLAD-Fundação Luso-Americana para o Desenvolvimento, CCDRN-Comissão de Coordenação e Desenvolvimento Regional do Norte, ABEU-PCO, Professional Congress Organizer, and Teatro Nacional S. João/Secretaria de Estado da Cultura.

We are particularly indebted to all *Symposium Promoters* for the coordination of the different themes and to the authors for their papers and presentations. The different contributions during the conference offered opportunities for thorough discussions with the authors. We acknowledge all of the participants, who contributed with innovations, new research approaches, novel techniques and testing methodologies, and their invaluable critical comments.

We are also indebted to the eleven outstanding *Plenary Lecturers* who highlighted the conference themes with their contributions: Dr. Shaker A. Meguid (University of Toronto/Canada), Dr. Gustavo B. Guimarães (Manufacture Engineering, EMBRAER/Brazil), Dr. Yoshiharu Morimoto (Moire Institute Inc., and Wakayama University, Wakayama, Japan), Dr. Emmanuel Gdoutos (Democritus University of Thrace, Greece), Dr. Robert A.W. Mines (University of Liverpool, United Kingdom), Dr. Sergei T. Mileiko (Russian Academy of Sciences, Russia), Dr. Michael B. Prime ((Los Alamos National Laboratory, USA), Dr. Mário A.P. Vaz (University of Porto, Portugal), Dr. Josef Eberhardsteiner (Vienna University of Technology, Austria), Dr. José Ygnacio Pastor (Technical University of Madrid, Spain), and Dr. Alfredo C. Campos (LNEC, Portugal).

Finally, we wish to express our gratitude to the members of the International Scientific Committee for reviewing the papers and the Proceedings, and to the members of the Local Conference Organizing Committee: António T. Marques, Paulo T. de Castro, A.J.M. Ferreira, Carlos C. António, Jorge Seabra, J.D. Rodrigues, Clito F. Afonso, Álvaro Cunha, Elsa Caetano, and Rui C. Barros, and the National Organizing Committee: João Ferreira (IST, Lisbon), Jorge Gomes (LNEC, Lisbon), José M. Cime (UC, Coimbra), Paulo G. Piloto (IPB, Bragança), Mário Santos (LNEG, Lisbon).

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