RECENT ADVANCES IN
INTEGRITY-RELIABILITY-FAILURE

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

Proceedings of the 4th International Conference on Integrity, Reliability and Failure, Funchal, Portugal, 23-27 June 2013

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About the Book

Innovative engineering in mechanics, materials and systems have witnessed the most significant progress in recent years. Important and dramatic improvements in component design will continue to be made by the use of the latest advances in mechanics, materials and manufacturing processes. Different tools are available to optimize any engineering solution, and we must continue our efforts to develop and use superior materials, apply reliable analytical and numerical techniques and validate these with sound experimental methods. 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 dimension and perspectives to minimize or prevent catastrophic failures of engineering systems, structures and components.

This volume contains the extended Abstracts of the 380 papers accepted for presentation in the IRF2013-4th International Conference on Integrity, Reliability and failure held in Funchal/Portugal, 23-27 June 2013. The book is complemented by an accompanying CD-ROM containing the full length papers.

IRF2013 is part of a prestigious series of conferences that was initiated in 1999, in Porto (Portugal), 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, and the conference themes focused on nanoengineering, computational and structural mechanics, micromechanics, experimental mechanics, advanced materials, thermo-fluid systems and case studies, among other engineering topics.

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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
EURASEM-European Society for Experimental Mechanics
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
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Symp_04: Optical Techniques of Experimental Mechanics in Design
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Symp_05: Blood Flow Mechanical Behaviour
Coordinators: Catarina Castro (U.Porto), Luisa Sousa (U.Porto)

Symp_06: Integrity, Reliability and Failure in Dental Materials
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RECENT ADVANCES IN INTEGRITY-RELIABILITY-FAILURE

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Proceedings IRF2013
4th International Conference on Integrity, Reliability and Failure
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SYMPOSIUM_18
Safety of Wooden Structures

Coordinators:

Elza M.M. Fonseca[*]
Department of Applied Mechanics, Polytechnic Institute of Bragança, Portugal
Débora R.S.M. Ferreira[*]
Department of Applied Mechanics, Polytechnic Institute of Bragança, Portugal

[*]Associate Editors for the papers in this Symposium

PAPER REF: 4089

NUMERICAL MODEL TO ASSESS THE FIRE BEHAVIOUR OF CELLULAR WOOD SLABS WITH DRILLINGS

E.M.M. Fonseca(*), L.M.S. Barreira, J.M. Meireles, P.A.G. Piloto
Polytechnic Institute of Bragança, Bragança, Portugal
(*)*Email:* efonseca@ipb.pt

ABSTRACT

The main goal of this paper is to develop a numerical model to assess the fire behaviour of cellular wood slabs with different drillings. A transient thermal analysis with nonlinear material behaviour will be solved with ANSYS program. The presented numerical model is based on a constructive solution proposed by Frangi and Fontana. The numerical results obtained will be compared with the experimental results from the reference. The developed numerical model allows future studies and simultaneously characterizes the effect of perforations in wooden slabs to minimize the fire risk. The numerical model can easily be adjusted for other constructive solutions, to facilitate the verification of safety in case of fire, in buildings with several wood floors and slabs assemblies.

Keywords: cellular wood slab, fire, drilling, perforation.

INTRODUCTION

Wood is a natural material with good structural characteristics. Wood is strong in relation to its weight (Mackerle, 2005). Many wood constructions are used and the focus of this work is to present a typical cellular slab for floors or roofs assemblies. The cavities of these elements could be filled with insulation or wood-based fiberboards.

Different works have been presented by researchers presenting analytical methods and experimental procedures to evaluate the physical degradation of wood due fire action (White, 1999), (Poon, 2003), (Janssens, 2004), (Frangi, 2004).

When wood is exposed to fire produces a surrounding charring depth layer. This charcoal layer has no mechanical resistance and causes a reduction in the cross-section element. The size of the wood slabs and the provided insulation play an important role on fire safety. Also, the size of the perforations in wooden slabs could delay the heating process though the thickness of the slab.

The main objective of this work is to present a numerical model to compare the experimental results from Frangi el al (Frangi, 2004) using the cellular wood slab with drillings subjected to fire. The effect of size drilling and the use of internal fibreboard material will be verified to evaluate the thermal effect into the cellular wood slab.

RESULTS AND CONCLUSIONS

This study considers a cellular wood slab with different types of drillings, and with or without internal fibreboard, exposed to fire, as represented in the figure 1. Thermal properties are considered according the Eurocode 5 (CEN, 2003). The effect of fire is considered using the appropriate boundary conditions due to convection and radiation. The temperature environment follows the standard fire ISO 834 curve.

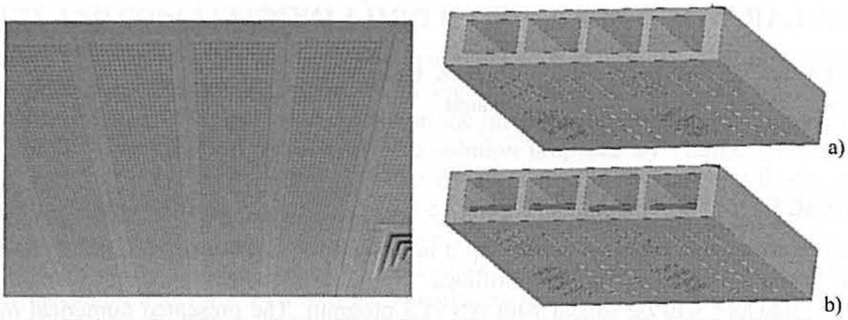

Fig. 1 - Applications of cellular wood slab with drillings. 3D CAD a) without fibreboard, b) with fibreboard.

Figure 2 represents the temperature evolution at one side fire exposure in a cellular wood slab without fibreboard. The effect of the drilling size is visible and produces a delay in the charring layer formation.

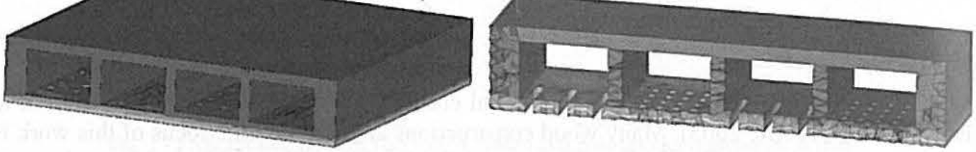

Fig. 2 - Temperatures in cellular wood slab, without fibreboard insulation.

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