J.F. Silva Gomes
Shaker A. Meguid
Editors

RECENT ADVANCES IN MECHANICS AND MATERIALS IN DESIGN

Proceedings of the 6th International Conference on Mechanics and Materials in Design, P. Delgada, Portugal, 26-30 July 2015

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About the Book:

During the last few decades the development of computer based techniques, as well as new experimental methods, nanotechnologies and nanomaterials, among many other material technological advances, added new dimension and perspectives to mechanical design and manufacturing of engineering systems, structures and components. Different tools are now 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.

This volume contains the extended Abstracts of papers accepted for presentation in the *M2D2015 - 6th International Conference on Mechanics and Materials in Design* held in Ponta Delgada/Portugal, 26-30 July 2015. The book is complemented by an accompanying CD-ROM containing the full length papers.

M2D2015 is part of a prestigious series of conferences that was initiated in 1996, in Toronto (Canada), coordinated by the International Scientific Committee on Mechanics and Materials in Design. The conference attracted over 320 participants with 423 accepted submissions from 42 different countries around the world. These papers were presented in July 26-30, 2015 in the magnificent city of Ponta Delgada-Azores, Portugal. The conference themes, which address novel and advanced topics in Mechanics and Materials in Design, focused on analytical and numerical tools at all scales, testing and diagnostics, surface and interface engineering, tribology, mechanical design and prototyping, modes of failure, composite and engineered materials, biomechanics, energy and thermo-fluid systems, impact and crashworthiness and case studies.

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M2D2015

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EDITORS' PREFACE

M2D2015 is the sixth international gathering of a prestigious series of conferences coordinated by the International Scientific Committee of Mechanics and Materials in Design. This series of conferences are wholy devoted to advances in mechanics, materials, structural integrity and design. M2D2015 is sponsored by the University of Porto, the University of Toronto and the University of Azores. The conference attracted over 320 participants with 423 accepted submissions from 42 countries out of 620 submissions. These papers were presented in July 26-30, 2015 in the magnificent city of Ponta Delgada, Azores. The conference themes which address novel and advanced topics in Mechanics and Materials in Design focused on analytical and numerical tools at all scales, testing and diagnostics, surface and interface engineering, tribology, mechanical design and prototyping, modes of failure, composite and engineered materials, biomechanics, energy and thermo-fluid systems, impact and crashworthiness and case studies.

We believe that the meeting offered our delegates a forum for the dissemination of their recent work in mechanics and materials and their applications in engineering design, fostered research that integrates mechanics and materials in the design process, and promoted exchange of ideas and international co-operation among scientists and engineers in this important field of engineering.

We are particularly indebted to the authors and special guests for their presentations. Each of the more than 420 contributions offered opportunities for thorough discussions with the authors. Particularly, we acknowledge the excellent contributions of the participants, their innovative ideas and research directions, the novel modeling and simulation techniques, and the invaluable critical comments. We are also indebted to the outstanding keynote speakers who highlighted the conference themes with their contributions and covered the main topics of the conference. We also take this opportunity to thank the members of the International Scientific Committee and the reviewers for their time, effort and helpful suggestions.

We offer our sincere gratitude to the symposia organisers for their efforts and valuable contributions to the success of the event, and the local organising committee for attending to the conference demands and delegates needs.

All in all, M2D2015 was a great success and the credit must go to all the participants for their significant contributions and lively discussions, the keynote speakers for bridging the gap between the different disciplines and the organizing committee for an absolutely superb organization of the meeting in this magnificent city. To all of you, we offer our gratitude.

Given the rapidity with which science is advancing in all areas of mechanics and materials, the next conference in this series (Integrity, Reliability and Failure - IRF 2016) will take place in Porto, Portugal in July 2016. Undoubtedly, we expect IRF2016 to be as stimulating and interesting as M2D2015, as evidenced by the excellent contributions offered in this current event. We look forward to seeing all of you in Porto in 2016.

Shaker A. Meguid and J.F. Silva Gomes
P. Delgada / Azores, July 2015

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PAPER REF: 5599

FIRE RESISTANCE OF CELLULAR WOODEN SLABS WITH RECTANGULAR AND CIRCULAR PERFORATIONS

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ABSTRACT

This work presents a numerical approach in order to predict the behaviour and the performance of typical cellular wooden slabs with rectangular and circular perforations when submitted to fire conditions. For this purpose a 3D numerical model was validated with different experimental tests at real scale obtained in laboratory in four cellular wooden slabs. This study was conducted in accordance with European standard EN 1365-2 and using a fire resistance furnace which complies the requirements of EN 1363-1. The thermal performance of the slab and the charring rate of the exposed surface will be compared for each type of perforations.

Keywords: Cellular wooden slab, perforation, fire.

INTRODUCTION

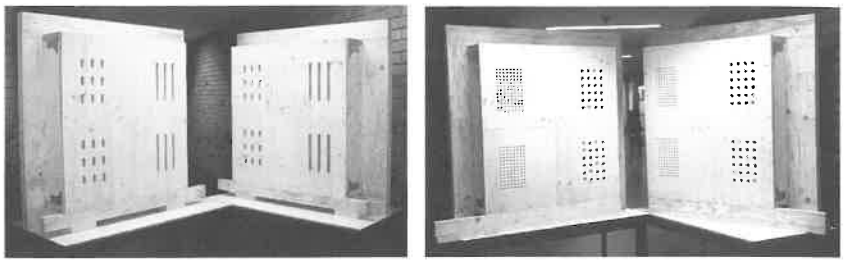
Wood when exposed to fire produces a surrounding charring depth layer, with no mechanical resistance, and causes a reduction in the cross-section element. In perforated cellular wooden slabs, the size of the perforations could influence the fire effect over the slab thickness. In this work, the main objectives are: present a numerical model validated with experimental tests to predict the evolution of the charring layer during a fire scenario using a finite element method with appropriate material properties and boundary conditions; determine the charring layer of different constructive solutions using wooden slabs with rectangular and circular perforations; determine the fire resistance in such way that contributes for a safe design in typical perforated wooden slab. The subject of this work is a study in progress according others investigations realized by the authors of this work (Fonseca et al. 2013).

WORK IN PROGRESS

In this work, four wooden slabs were considered for analysis. The geometric model of each slab considers three different cellular zones (two cells with different perforations and one cell with no perforation). Slab 1 and 2 present two types of rectangular perforations (250x20) mm and (40x20) mm, in the exposed surface. Slab 3 and slab 4 present circular perforations with a diameter equal to 10 mm and 20 mm, as represented in figures 1 and 2.

The slabs were tested on fire resistance furnace. In the experimental tests, thermocouples were installed to measure the temperature in different locations (unexposed surface of the floor plate, beams, steel connectors and cellular zones), see Fig. 3 respectively. For numerical simulation, a finite element method was used for nonlinear thermal transient analysis, using Ansys.

Fig. 1 - Wooden slab with cellular zones.



Slab 1 and slab 2. Slab 3 and slab 4.

Fig. 2 - Cellular wooden slabs with rectangular and circular perforations.

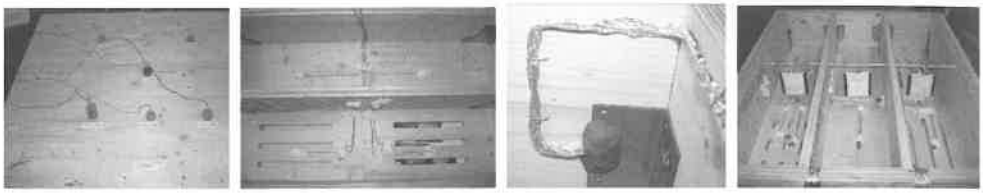


Fig. 3 - Thermocouples installation.

This study shows the evolution of the temperature and the char-layer throughout a wooden slab. The thermal behaviour of the each component was characterized and the evolution of the temperature inside the cellular zones. Also, the shape and the size of perforations could be assessed and compared with the unperforated cellular zone. The size of the perforation is responsible for different charring rates. The charring rate of the cell with no perforation is in accordance to the expected values of EN1995-1-2. The damage effect of fire is higher in the slab with larger perforations, as expected.

ACKNOWLEDGMENTS

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