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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FIRE BEHAVIOUR OF TABIQUE WALL - EXPERIMENTAL AND NUMERICAL STUDY

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ABSTRACT

This paper present a study on the behaviour of *tabique* walls, concerning its fire resistance. This work is based on the experimental analysis of real scale *tabique* panels. Such panels were made in pine wood with an earth-based mortar finishing. In order to assess the earth-based mortar thickness effect on the fire resistance of the wall, three specimens were tested with different mortar thicknesses of 15 mm, 10 mm and 5 mm. The experimental models were tested in a fire-resistance furnace according to the ISO 834 standard fire curve. A numerical model was developed in order to assess the *tabique* wall behaviour under fire conditions and was validated with experimental results.

Keywords: Fire, *tabique*, traditional building techniques.

INTRODUCTION

The *tabique* is one of the main Portuguese traditional building techniques, which is based on raw materials as earth and wood. In general, a *tabique* wall is composed by a simple timber structure covered with an earth-based material. Nowadays, the existing *tabique* constructions show a generalized and advanced stage of deterioration (Cunha, 2014). This concern, along with the fact that there is still a lack of investigation in this field, motivated this work which main goal is to study experimentally and numerically the behaviour of the *tabique* wall under fire conditions using different earth-based mortar thicknesses.

The manufactures of *tabique* walls relies on a lightweight timber structure assembled with pine planks placed vertically on which horizontal battens are nailed on both sides (Araújo, 2014). In order to evaluate the earth-based mortar thickness effect, three panels with different mortar layer thicknesses of 15 mm, 10 mm and 5 mm were tested.

The thermal behaviour of *tabique* panels exposed to the fire action was evaluated using several thermocouples meant for measuring both internal and external temperatures of the wall. The entire procedure is based on (EN 1364-1, 1999). The main goal of this study is to assess the behaviour of the earth-based mortar layer that protects the timber structure which constitutes the *tabique* wall. Hence, thermocouples were placed at different depths in order to obtain temperature records inside the mortar (TA) and in wood (TM). The unexposed surface was also analysed with disk thermocouples (TD).

The specimens were tested in a fire-resistance furnace (Fig. 1) according to the ISO 834 standard fire curve. During the tests, the integrity of the panels was evaluated throughout the cotton pads test and gap gauges, as well as monitoring the test specimen regarding evidence of sustained flaming. However, there was a significant amount of smoke release from burning wood at final stage of the test, Fig. 2. The insulation was also evaluated during tests measuring the unexposed surface temperature.

Fig. 1 - Experimental *tabique* wall

Fig. 2 - Smoke release

RESULTS AND CONCLUSIONS

The graphs in Fig. 3 and Fig. 4 show the obtained results from experimental fire exposure (T_e) and the numerical responses (T_n), in *tabique* panel with a 15 mm thick mortar layer, both for TM and TA thermocouples, respectively.

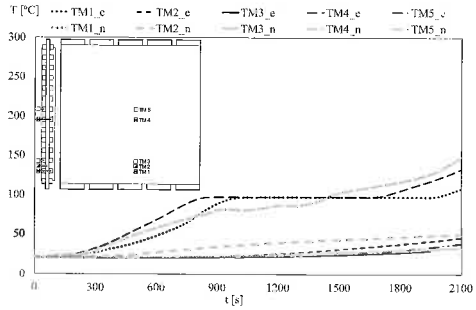

Fig. 3 - Time-temperature history on wood structure

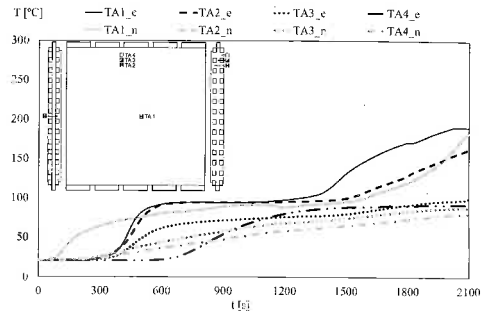

Fig. 4 - Time-temperature history on earth-based material

Experimental results allow the authors to point out that both performance criteria (insulation and integrity) defined according to the European standard for fire resistance tests (EN 1362-1, 1999) were fulfilled for the whole test duration of the three *tabique* panels. The numerical curves show good agreement with experimental results.

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