RECENT ADVANCES IN INTEGRITY-RELIABILITY-FAILURE

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

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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
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A CONTRIBUTION TO ASSESS THE STRUCTURAL VULNERABILITY OF TRADITIONAL TIMBER PAVEMENTS

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ABSTRACT

In general, timber pavements are the main horizontal structural elements of the Portuguese traditional buildings. Since these types of buildings required to be preserved, the maintenance of timber pavements is crucial. However and unfortunately, the demolition of the interior of traditional buildings still is a current building option in rehabilitation processes. This building scenario is more expressive in private estate, in particular, in private dwellings. This option may be due to the lack of technical knowledge concerning timber pavements. Therefore, this paper intends to give a contribution in this matter by proposing an expedite methodology able to assess the structural vulnerability of these types of horizontal structural elements. Mapping the different structural vulnerability degrees of a traditional timber pavement may give guidance for maintenance, inspection and/or reinforcement design processes.

Keywords: traditional timber pavements, structural timber elements, structural vulnerability, pathology, mitigation, sustainability

INTRODUCTION

Granite, schist and tabique building are traditional Portuguese buildings. The differentiation of these types of buildings is basically related to the type of the respective main external vertical structural elements. In all the cases, the main external vertical structural element is a wall and instead of a column. Granite masonry, schist masonry and tabique wall are the main external vertical structural elements of the granite, the schist and the tabique traditional buildings, respectively. There is also the case of mixed type in which, an integrated combination of the above identified vertical structural elements is possible. For instance, this building scenario is highly expected in tabique buildings because stone masonry (e.g. granite or schist) placed at the ground floor level usually support the upper external tabique walls. In general, these types of traditional buildings have interesting building patterns such as, local and natural building materials, and an interior timber component tendency. In fact, the pavements, the stairs, the roof's structure and the partition walls are preferentially timber structural components. In the context of traditional timber pavements, they are essentially a braced beamed load distribution structural systems.

Apart of supporting dead and live loads, the timber pavements also support the self-weight of the partition walls. Meanwhile, they are essentially directly supported on the external walls and, therefore, they also may have an important bracing contribution of the overall building. These technical aspects lead us to the conclusion that the traditional timber pavements may have an important role in the overall structural integrity of traditional buildings. Pathology phenomenon, material and structural damages, and structural failure scenarios are some aspects that have to be considered concerning maintenance, inspection, structural reinforcing design and rehabilitation processes of traditional timber pavements. Additionally, the aging effect, the fact that wood is an organic building material (resulting in a heterogenic and anisotropic material), the building may be in service and no original design is likely to happen, are also aspects that have to be considered in these processes. Therefore, these processes may end up being complex. On the other hand, in the perspectives of cultural, social identity, sustainability and economical, to preserve the traditional buildings is a wise option. Unfortunately, this option is still frequently neglected and mainly concerning the rehabilitation of private traditional estate (e.g. dwellings), in which the demolition of the existing timber structural elements is a common decision. In other to invert this situation, technical knowledge dissemination among the community is required. In this respect, this paper intends to contribute by given a step forward on the structural vulnerability assessment of traditional building pavements and by integrating the typical pathology damages of structural timber elements with the critical structural point concept.

The most structurally vulnerable parts of a traditional timber pavement may be identified which may be extremely useful in the processes identified above. A similar approach has been done for the traditional timber roof structures (Murta, 2011) This paper is structured as follows: firstly, the traditional building topic is put into context. In particular, the main types of the traditional buildings of the Trás-os-Montes e Alto Douro region are briefly identified and described; secondly, some structural timber systems of traditional pavements are presented and described; thirdly, the most common timber pathologies are identified and exemplified; fourthly, a proposal of an expedite methodology for the assessment of the structural vulnerability of traditional timber pavements is done; finally, the main conclusions are drawn.

RESULTS AND CONCLUSIONS

The main traditional buildings of the north-east part of Portugal are identified and briefly described. Some typical timber pavements are presented and also their most frequent pathologies. An expedite methodology for the structural vulnerability assessment of these types of horizontal structural elements is explained and proposed.

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[1]-Murta, A., Pinto, J., Humberto Varum, H. (2011) - Structural vulnerability of two traditional Portuguese timber structural systems. Engineering Failure Analysis (2011), doi:10.1016/j.engfailanal.2010.12.017.