RECENT ADVANCES IN INTEGRITY-RELIABILITY-FAILURE

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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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JSME-Japanese Society of Mechanical Engineering
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PAPER REF: 4524

DIMENSIONAL STABILITY OF WOOD IN PRESENCE OF WATER

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ABSTRACT

Moisture is one of the most important causes for building pathology. The material degradation can be affected by the presence of water, both in vapour and liquid phase. Wood has a strong hygroscopic behaviour, with a strong variation of moisture content and dimension stability caused by modifications of the relative humidity of the surrounding air. The properties that define the behaviour of wood against temperature and moisture actions were studied in this work. Hygroscopicity and shrinkage were given special attention.

Keywords: hygroscopic, wood, experimental evaluation, dimensional changes.

INTRODUCTION

Wood is our most important raw material. It is important not only because it is used for literally hundreds of products, but also because it is a renewable natural resource. Through a carefully and planned use, forests could provide a perpetual supply of wood. All wood in growing trees contains a considerable amount of water as part of the photosynthesis and the growing processes. This water is commonly called sap. The main goal of this work is to study the water movement in wood: first of all, the drying process, which occurs before the manufacture and use as finished wood products, and secondly the gain and loss of water in response to changes in environmental conditions that surround the wood. The moisture content relationship has an important influence on wood properties and performance (White et al, 1999).

Wood is dimensionally stable when moisture content is greater than the fibre saturation point (MCfs). Below MCfs wood dimensional changes and it gains moisture (swells) or loses moisture in the form of bound water. The level of MCfs depends on the relative humidity and temperature of the surrounding air. Shrinkage and swelling are the cause of many of the problems that occur in wood during drying and in use, therefore, an understanding of them will help minimize such problems. Splitting, warping, and open joints are examples of problems that occur due to uneven shrinkage.

WORK IN PROGRESS

An experimental program was defined with the aim to evaluate the dimensional stability of hardwood and softwood species. The maritime pine softwood (Pinus pinaster) and the chestnut and oak hardwood (Quercus prinus) of the North-east region of Portugal will be analysed. A group of thirty specimens were made for each specimens of wood. The experimental procedure will be made according NP EN 614 and NP EN 615. The specimens will be dried in a oven-dry with the references conditions of T=103ºC±2ºC. As the moisture content of the specimens is changed, until achieving the hygroscopic equilibrium of the

environment, the measurements were taken being possible to quantify the dimensional variation suffered during this process. The geometry assumed for the specimens was 40x40x10, based on the NP EN 614 recommendations. For all measurements, a dial gauge was used with a calibrated precision equal to 0,001 mm coupled to a steel base was used (Fig.1).

For each measurement, the moisture content in wood specimens will be calculated using an oven-dry method suggested by NP EN 614. Therefore, it will be possible to assess the weight loss of each specimen for the three wood species.

The weight of moisture contained in a wood sample, as a percentage of its oven dry, is expressed according the following equation:

$$m_c = \frac{W_g - W_0}{W_0} \times 100$$

where m_c=moisture content; W_g=green weight of the wood and W_o=oven dry weight of the wood.

The following figures represent the experimental setup used to measure the moisture content in all specimens. Fig. 2 represents the oven-dry method and Fig. 3 presents the geometry assumed for the specimens based on NPEN 614 and NPEN 615.

Fig. 1 - Test setup used to measure

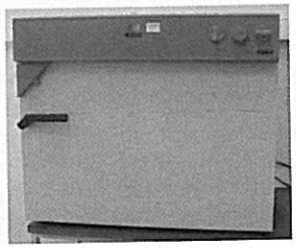

Fig. 2 - Oven-dry method

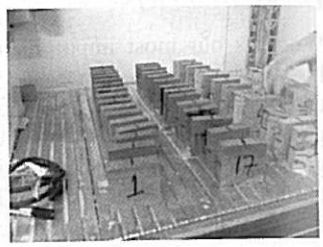

Fig. 3 - Specimens wood sections

Conclusions about the moisture content in hardwoods and softwoods of the North-east region of Portugal will be included. In general, hardwoods typically have a % of moisture content between 60-100%, while softwoods have different values according in on heartwood (30-100%) or sapwood (110-220%).

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