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: 5628

TENSILE STRENGTH OF PINE AND ASH WOODS - EXPERIMENTAL AND NUMERICAL STUDY

Débora Ferreira[1(*)], Elza Fonseca[1], Cristiana Pinto[1], Paula Borges[1]
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ABSTRACT

Timber structures are a competitive solution when compared to steel and concrete structures, showing features and advantages that overcome their competitors: weight/strength ratio, rapid assembly, fire resistance and excellent performance in earthquake scenario, natural aesthetic attractiveness, and ecological rationality which leads to sustainable construction. The main goal of this experimental and numerical study was to evaluate, using tensile tests, the mechanical characteristics of two different wood species: Pine and Ash. For tensile test a total of twelve samples for each wood species were prepared, six of them were cut in the wood transverse to the grain, with dimensions equal to 190×50×9 mm, and the others six were cut in the wood parallel to the grain with the dimensions equal to 210×40×9 mm. A numerical simulation was also conducted in order to assess the stress-strain behaviour of Pine and Ash woods.

Keywords: wood, tensile strength.

INTRODUCTION

The mechanical properties define the behaviour of the timber when subjected to mechanical stresses, resulting directly from the timber anisotropic and heterogeneity properties. The tensile strength of wood being constant above the fibre saturation point, it increases with decreasing moisture content below the fibre saturation. This can be related to where the water is absorbed in the microstructure. Their study is of great interest for allowing the rational use of different wood species for structural and building purposes. The EN 408 standard defines the test procedure in order to obtain the mechanical properties of wood.

The tensile strength of wood parallel to the grain depends upon the strength of the fibres and is affected by the nature and dimensions of the wood elements, and also by their arrangement. The highest value is obtained in straight-grained specimens with thick-walled fibres.

Cross grain of any kind of material reduces the tensile strength of wood, since the tensile strength at right angles to the grain is only a small fraction of that parallel to the grain (Record, 2004). The wood properties are conditioned as well by the anatomical characteristics such as knots, cross grain and checks. Different values were obtained depending on four issues: compressive or tensile test, as well as the cut direction (parallel or transverse to the grain).

Comparatively, wood exhibits its maximum strength in tension parallel to the grain. Two different representative samples have been made of each wood specimen. Fig. 1 and Fig. 2 show the dimensions for specimens cut in wood transversally and parallel to the grain, respectively.

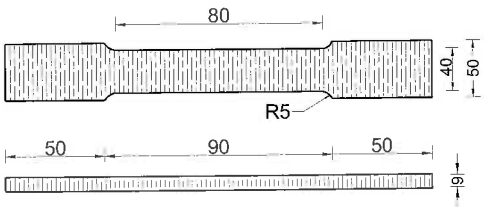

Fig. 1 - Specimen cut transverse to the grain

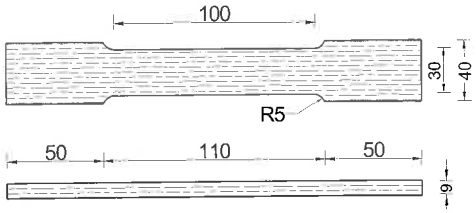

Fig. 2 - Specimen cut parallel to the grain

The experimental results were used to calibrate the numerical simulations conducted in ANSYS software with solid finite elements.

RESULTS AND CONCLUSIONS

The experimental and numerical results, from the tensile tests regarding Ash wood in the directions transverse and parallel to the grain, are shown in Fig. 3 and Fig. 4, respectively.

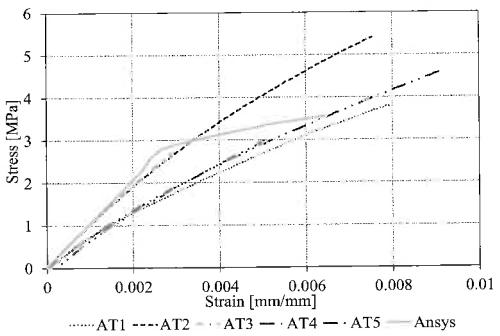

Fig. 3 - Stress-strain behaviour in Ash cut perpendicular to the grain

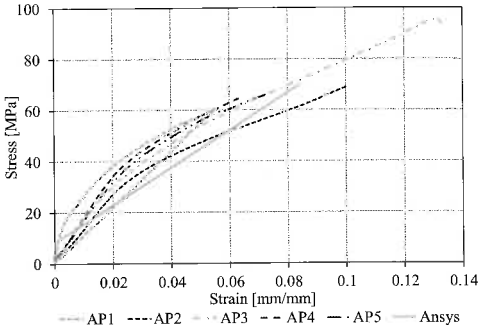

Fig. 4 - Stress-strain behaviour in Ash cut parallel to the grain

From results one can observe a highest strength in the parallel direction when compared with the one perpendicular to the grain. The specimens reached different tensile stress values corresponding to different strains. Regarding specimens cut in the longitudinal direction, an average value of 70 MPa was obtained, while for specimens cut in the transverse direction the tensile strength was less than 6 MPa. In both cases the wood presented a brittle behaviour. The numerical curves are in accordance with the experimental results.

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