Universitatea Transilvania din Brașov

HABILITATION THESIS

SUMMARY

Title: The mechanical behavior of complex lignocellulosic structures of the Helmholtz type

Domain: Mechanical Engineering

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The habilitation thesis entitled ***The mechanical behavior of complex lignocellulosic structures of the Helmholtz type*** presents the scientific and didactic achievements conducted by author after obtaining of the scientific title of *doctor (PhD*), in the field of the *mechanical engineering (July, 2009)* and as Associate Professor at the Faculty of Mechanical Engineering, Transilvania University of Brașov. In the first part, the habilitation thesis approaches a research theme in the mechanical engineering field, which refers to the modeling, simulation and mechanical and dynamical testing of complex lignocelulloses structures type Helmholtz resonator, study cases - the strings muzical instruments (violins and classical guitar). Discussed here are only the scientific achievements that are the subject of the habilitation thesis and are published in the **11 ISI articles (Q1 and Q2), 14 scientific papers** presented at various national and international events, interim reports of projects coordinated by the author of the thesis, guidance of 3 bachelor's theses and 2 dissertation papers with topics related to the subject of the habilitation thesis. In addition to the topic of her doctoral thesis, the author dealt with research on the effect of accelerated aging of wood and lignocellulosic composite materials resulting in 4 articles ISI and 5 BDI, the study of visco-elastic properties of composites reinforced with glass fibers (published in 2 ISI articles, 5 BDI), research on the sound-absorbing and thermal insulating properties of composites (2 ISI articles, 3 BDI) and last but not least, studies on the mechanical and dynamic properties of metals (1 ISI article, 4 BDI).

The reason for choosing of the theme are based on: continuation and development of research directions initiated during the doctorate; the existence of a pole of processing resonant wood in the form of stringed muzical instruments, in Reghin, also called the city of violins; recognition of the quality of Romanian resonant wood and the mastery of Romanian luthiers through exports over 90% of factory production – S.C. Hora S.A. Reghin and S.C. Gliga Muzical Instruments S.A .; opening the factory management to fundamental, applied and experimental research on the problems of stringed muzical instruments; the lack of coherent and consistent research in our country, on these mechanical structures with acoustic and artistic role.

In Chapter 1 intitled ***Geometric, mechanical and dynamic models of stringed musical instruments,*** one presents both the main parts of violin and guitar structures, the main wooden species used for them in comparison with old muzical instruments (studied case of violin) by means of imagistic method (X-ray scanning, computer tomography scanning). After identifying the geometric and constructive peculiarities of old and new violins, resulting in digitized anatomical models of wood structure and geometric models of violins, the mathematical model of Helmholtz-type structures is presented, assuming symmetrical and quasi-symmetrical systems, taking as a study case, the body of the classical guitar. Finally, the numerical models of the plates from the construction of the violin obtained by the finite element method are presented,

and the results of their modal analysis were correlated with those from the state of the art. The research results presented in Chapter 1 were disseminated in 8 scientific articles (**4 papers in ISI quoted journals and 4 presented at international scientific events**) as well as in the progress reports on the projects coordinated by the author PN-III-P2-2.1-BG 85/2016 and PN-III-P2-2.1-PED-568PED / 2020. Detailed information on the dissemination of results is presented at the end of Chapter 1. The scientific contribution was as "author principal "or" corresponding author "for the vast majority of these publications.

The chapter 2, ***Determination of the elastic, dynamic and acoustic properties of wood used in complex Helmholtz structures,*** is dedicated to experimental investigations on the elastic, acoustic and dynamic properties of the raw material: spruce wood (*Picea Abies* L. Karst), maple wood (*Acer pseudoplatanus* L.), species used for the body of muzical instruments and acacia wood (*Robinia pseudacacia* L.) used for the fretboard of some categories of classical guitars. The specimens of the two studied resonance species were divided into four anatomical quality groups, in accordance with the quality classes of muzical instruments (class A - maestro, class B - professional, class C - student, class D - school). After defining the main elastic/acoustic/ dynamic parameters that are specific to the resonant wood, the results regarding the speed of sound propagation in wood are presented, the elastic properties (modulus of elasticity on the three directions of wood) determined by two methods: the method with ultrasound and that of the intrinsic transfer matrix, all results being correlated with the anatomical structure of the wood (anatomical model). The last subchapter (2.3) is dedicated to the determination of the dynamic modulus by mechanical analysis in dynamic regime, in isothermal conditions and with temperature variation, experimental tests that highlighted the visco-elastic behavior of wood from spruce, maple, acacia species. The results of the research in Chapter 2 were disseminated in 9 scientific papers (4 ISIs different from those presented in Chapters 1 and 5 ISI Proceedings), to which can be added the author's contribution as a supervisor of a dissertation (from the Faculty of Mechanical Engineering 2021) and the second bachelor's thesis (from the Faculty of Wood Engineering 2015). Also, parts of chapter 2 constituted interim reports of projects PN-III-P2-2.1-BG 85/2016 and PN-III-P2-2.1-PED-568PED / 2020. Detailed information on the dissemination of results is presented at the end of Chapter 2.

The **chapter 3, Statical and dynamic behavior of complex lignocellulosic structures in the construction of stringed muzical instruments** is dedicated to presenting the results of applied research undertaken within the BG59/2016 and PED568/2020 research projects. In the first section, the mechanical analysis of subassemblies and ensembles in guitar construction, from the perspective of factors that influence their behavior over time are presented, being analysed the mechanical behaviour of guitar neck as a cantilever beam, with variable section

from stratified lignocellulosic materials. The relativ air humidity was varied to observe the mechano-sorptive effects of wood in case of free structures and cantilever beams. Then, the stresses and strains states of guitar when the strings are tension, were determined by means of electrical - resistance strain gage. Finally, the dynamical behaviour of new and old violins as complex lignocellulosic structures were investigated, the results being correlated with wood species, thickness of violin plates and symmetry of structure. The results of the research in Chapter 3 were disseminated in 8 scientific papers (3 ISIs different from those presented in Chapters 2 and 3 and 5 presented at scientific events), to which can be added the author's contribution as a guide to two dissertation papers. at the Faculty of Mechanical Engineering 2021. Also, parts of chapter 3 constituted interim reports of the projects PN-III-P2-2.1-BG 85/2016 and PN-III-P2-2.1-PED-568PED / 2020. Detailed information on the dissemination of results is presented at the end of Chapter 3. The scientific contribution was the "lead author" or "correspondent author" for the vast majority of these publications.

Chapter 4 is dedicated to the presentation of personal and original contributions and future research directions specific to the topic presented in the habilitation thesis**.**

Chapter 5 presents the evolution and achievements on a professional level (academic, didactic and scientific), and in **chapter 6** is detailed the professional academic development plan.