

## Material properties and nondestructive evaluation of laminated veneer lumber (LVL) made from *Pinus oocarpa* and *P. kesiya*

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**Abstract** This study aimed at evaluating the mechanical, physical and biological properties of laminated veneer lumber (LVL) made from *Pinus oocarpa* Schiede ex Schltdl (PO) and *Pinus kesiya* Royle ex Gordon (PK) and at providing a nondestructive characterization thereof. Four PO and four PK LVL boards from 22 randomly selected 2-mm thickness veneers were produced according to the following characteristics: phenol-formaldehyde (190 g/m<sup>2</sup>), hot-pressing at 150°C for 45 min and 2.8 N/mm<sup>2</sup> of specific pressure. After board production, nondestructive evaluation was conducted, and stress wave velocity ( $v_0$ ) and dynamic modulus of elasticity ( $E_{MR}$ ) were determined. The following mechanical and physical properties were then evaluated: static bending modulus of elasticity ( $E_M$ ), modulus of rupture ( $f_M$ ), compression strength parallel to grain ( $f_{c,0}$ ), shear strength parallel to glue-line ( $f_{c,0}$ ), shear strength perpendicular to glue-line ( $f_{c,90}$ ), thickness swelling (TS), water absorption (WA), and permanent thickness swelling (PTS) for 2, 24, and 96-hour of water immersion. Biological property was also evaluated by measuring the weight loss by *Trimetes versicolor* (Linnaeus ex Fries) Pilát (white-rot) and *Gloeophyllum trabeum* (Persoon ex Fries.) Merrill (brown-rot).

After hot-pressing, no bubbles, delamination nor warping were observed for both species. In general, PK boards presented higher mechanical properties:  $E_M$ ,  $E_{MR}$ ,  $f_M$ ,  $f_{c,0}$  whereas PO boards were dimensionally more stable, with lower values of WA, TS and PTS in the 2, 24, and 96-hour immersion periods. Board density,  $f_{c,0}$ ,  $f_{c,90}$  and rot weight loss were statistically equal for PO and PK LVL. The prediction of flexural properties of consolidated LVL by the non-destructive method used was not very efficient, and the fitted models presented lower predictability.

### Material Eigenschaften von Furnierschichtholz aus *Pinus oocarpa* und *Pinus kesiya* und deren zerstörungsfreie Prüfung

**Zusammenfassung** Ziel dieser Studie war die Bestimmung der mechanischen, physikalischen und biologischen Eigenschaften von Furnierschichtholz (LVL) aus *Pinus oocarpa* Schiede ex Schltdl (PO) und *Pinus kesiya* Royle ex Gordon (PK) sowie deren zerstörungsfreie Prüfung. Vier PO und vier PK Platten aus 22 zufällig ausgewählten 2 mm dicken Furnieren wurden wie folgt hergestellt: Phenolformaldehydharz (190 g/m<sup>2</sup>), Pressetemperatur 150 °C, Pressdauer 45 Minuten, Pressdruck 2,8 N/mm<sup>2</sup>. Nach der Herstellung der Platten wurde diese zerstörungsfrei geprüft und die Spannungswellengeschwindigkeit ( $v_0$ ) sowie der dynamische E-Modul ( $E_{MR}$ ) wurden bestimmt. Anschließend wurden die folgenden mechanischen und physikalischen Eigenschaften bestimmt: statischer Biege-E-Modul ( $E_M$ ), Biegefestigkeit ( $f_M$ ), Druckfestigkeit in Faserrichtung ( $f_{c,0}$ ), Scherfestigkeit in Richtung der Klebstoffuge ( $f_{c,0}$ ), Scherfestigkeit rechtwinklig zur Klebstoffuge ( $f_{c,90}$ ), Dickenquellung (TS), Wasseraufnahme (WA) und permanente Dickenquellung (PTS) bei 2-, 24- und 96-stündiger Wasserlagerung. Daneben wurde die natürliche

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# Nondestructive Evaluation And Material Properties Ii

**Forest Service (U S ),Forest Products  
Laboratory (U S ),Robert J. Ross**

## **Nondestructive Evaluation And Material Properties Ii:**

Nondestructive Evaluation and Material Properties II Peter K. Liaw, 1994-01-01 This collection of papers is from Materials Week 93 held in Pittsburgh Pennsylvania October 17 21 1993 The book intends to develop a fundamental understanding of relating non destructive evaluation NDE techniques to microstructures and material properties of metals polymers ceramics and advanced composite and intermetallic materials *Nondestructive Evaluation and Material Properties II* Minerals, Metals and Materials Society Staff, **Advanced Nondestructive Evaluation II - Proceedings of the International Conference on Ande 2007** Seung-Seok Lee, 2008 This volume comprises papers presented at the 2nd International Conference on Advanced Nondestructive Evaluation ANDE 2007 held in Busan Korea on October 17 19 2007 Many of the excellent papers included in this book show the current state of nondestructive technologies which are experiencing rapid progress with the integration of emerging technologies in various fields As such this volume provides an avenue for both specialists and scholars to share their ideas and the results of their findings in the field of nondestructive evaluation **Advanced Nondestructive Evaluation II.** Seung-Seok Lee, 2008 This volume comprises papers presented at the 2nd International Conference on Advanced Nondestructive Evaluation ANDE 2007 held in Busan Korea on October 17 19 2007 Many of the excellent papers included in this book show the current state of nondestructive technologies which are experiencing rapid progress with the integration of emerging technologies in various fields As such this volume provides an avenue for both specialists and scholars to share their ideas and the results of their findings in the field of nondestructive evaluation **Electromagnetic Nondestructive Evaluation (X)** Seiki Takahashi, Hiroaki Kikuchi, 2007 Since the first Electromagnetic Nondestructive Evaluation ENDE workshop was held in London 1995 the workshops have contributed to the technical advance in ECT through competition and collaboration This title focuses on Eddy Current Testing ECT to identify cracks in metals and alloys **Advanced Nondestructive Evaluation Ii (In 2 Volumes, With Cd-rom) - Proceedings Of The International Conference On Ande 2007 - Volume 2** Seung-seok Lee, Joon Hyun Lee, Ik-keun Park, Sung-jin Song, 2008-08-04 This volume comprises papers presented at the 2nd International Conference on Advanced Nondestructive Evaluation ANDE 2007 held in Busan Korea on October 17 19 2007 Many of the excellent papers included in this book show the current state of nondestructive technologies which are experiencing rapid progress with the integration of emerging technologies in various fields As such this volume provides an avenue for both specialists and scholars to share their ideas and the results of their findings in the field of nondestructive evaluation Advanced Nondestructive Evaluation Ii (In 2 Volumes, With Cd-rom) - Proceedings Of The International Conference On Ande 2007 - Volume 1 Seung-seok Lee, Joon Hyun Lee, Ik-keun Park, Sung-jin Song, 2008-08-04 This volume comprises papers presented at the 2nd International Conference on Advanced Nondestructive Evaluation ANDE 2007 held in Busan Korea on October 17 19 2007 Many of the excellent papers included in this book show the current state of nondestructive technologies which are experiencing rapid progress with the

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Electromagnetic Nondestructive Evaluation (II) R. Albanese, Guglielmo Rubinacci, Toshiyuki Takagi, Satish S. Udpa, 1998 Europe's place in the world throughout the narrative and in the primary source feature The Global Record The seventh edition has been carefully revised and edited for greater accessibility and features a streamlined design that incorporates pedagogical features such as focus questions key terms and section summaries to better support students of western civilization The reconceived narrative and restructured organization featuring smaller more cohesive learning units lend to greater ease of use for both students and instructors History CourseMate a set of media rich study tools with interactive eBook that gives students access to quizzes flashcards primary sources videos and more are available for this new edition CourseMate may be bundled with the text or purchased separately Available in the following split options WESTERN CIVILIZATION BEYOND BOUNDARIES Seventh Edition Complete Volume I To 1715 Volume II Since 1560 Volume A To 1500 Volume B 1300 1815 and Volume C Since 1789 Available with InfoTrac Student Collections <http://go.cengage.com/infotrac>

*Nondestructive Evaluation* Don E. Bray, Roderick K. Stanley, 2018-10-03 Nondestructive evaluation NDE inspection schemes are important in design manufacturing and maintenance By correctly applying techniques of NDE we can reduce machine and system failures and increase reliability of operating systems over an extended lifetime Nondestructive Evaluation A Tool in Design Manufacturing and Service introduces and discusses primary techniques used in the field including ultrasonics acoustic emission magnetics radiography penetrants and eddy currents Examples of each of these techniques are included demonstrating typical applications **Nondestructive Evaluation** Peter J. Shull, 2002-05-08 Describing NDE issues associated with real world applications this comprehensive book details conventional and forthcoming NDE technologies It instructs on current practices common techniques and equipment applications and the potentials and limitations of current NDE methods Each chapter details a different method providing an overview an e Review of Progress in Quantitative Nondestructive Evaluation Donald O. Thompson, Dale E. Chimenti, 2013-11-11 These Proceedings consisting of Parts A and B contain the edited versions of most of the papers presented at the annual Review of Progress in Quantitative Nondestructive Evaluation held at Bowdoin College Brunswick Maine on July 28 to August 2 1996 The Review was organized by the Center for NDE at Iowa State University in cooperation with the American Society of Nondestructive Testing the Ames Laboratory of the USDOE the Federal Aviation Administration the National Institute of Standards and Technology and the National Science Foundation Industry University Cooperative Research Centers program This year's Review of Progress in QNDE was attended by approximately 400 participants from the U S and many foreign countries who presented over 350 papers As usual the meeting was divided into 36 sessions with as many as four sessions running concurrently The Review covered all phases of NDE research and development from fundamental investigations to

engineering applications or inspection systems and it included many important methods of inspection techniques from acoustics to x rays In the last eight to ten years the Review has stabilized at about its current size which most participants seem to agree is large enough to permit a full scale overview of the latest developments but still small enough to retain the collegial atmosphere which has marked the Review since its inception *Electromagnetic Nondestructive Evaluation (XIII)* Jeremy Knopp,2010 The 14th International Workshop on Electromagnetic Nondestructive Evaluation ENDE was held at the Crowne Plaza Hotel in Dayton Ohio USA in July 2009 where the ENDE activities in the Dayton area reflect the local aerospace industry With 80 participants from over ten countries worldwide this workshop provided an important opportunity for an international exchange of information and ideas This book contains the proceedings of that workshop From the 59 oral and poster presentations 39 were submitted for publication Of these 37 peer reviewed papers appear in this volume These papers pr Review of Progress in Quantitative Nondestructive Evaluation Donald Thompson,2012-12-06 This Proceedings contains the edited papers presented at the annual Review of Progress in Quantitative NDE held at the University of California Santa Cruz Aug 7 12 1983 In it papers have been arranged topically by chapters and subsections rather than by order of presentation at the Review The editors believe that this format is preferable as a reference volume Thus the Proceedings contains nine chapters and subsections which provide broad coverage of topics of current interest in NDE research and development The Review was sponsored by the Center for Advanced NDE Ames Laboratory of the U S Department of Energy in cooperation with the Office of Basic Energy Sciences USDOE the Defense Advanced Research Projects Agency the Materials Laboratory of the Air Force Wright Aeronautical Laboratories and the Naval Sea Systems Command Approximately 275 attendees representing various government agencies industry and academia participated in the technical presentations poster sessions and discussions This Review possibly the most comprehensive annual symposium in NDE emphasizes both basic research and early engineering applications it provides a valuable forum for the transfer of technical information Para graphs given below provide a brief summary of the contents of the Proceedings Chapter 1 consists of four papers that discuss elements of NDE Reliability and contains the keynote paper given by Dr J M Coffey of the NDT Applications Centre Central Electricity Generating Board Manchester England In his paper Dr Handbook of Nondestructive Evaluation 4.0 Norbert Meyendorf,Nathan Ida,Ripudaman (Ripi) Singh,Johannes Vrana,2025-06-29 This handbook now as second edition continues to comprehensively cover the cutting edge trends and techniques essential for the integration of nondestructive evaluation NDE into the changing face of the modern industrial landscape In particular it delves into the marriage of NDE with new techniques in e g data mining and management cloud computing autonomous operation AI for data analysis and decision making as well as cyber security highlighting the potential for cyber physical controlled production and discussing the myriad possible applications across many different industries The Handbook of NDE 4 0 centers around the Industry 4 0 philosophy the next generation of industrial production encompassing all aspects of

networking across all industrial areas. It discusses the adaptation of existing NDE techniques to emerging new technological areas such as 3D printing via the introduction of cyber systems into the inspection and maintenance processes. In addition, the handbook covers topics such as the management and processing of big data with respect to real time monitoring of structural integrity and reliable inspection of individual components. Remote NDE to include competence not available on site will be a potential technique to increase reliability of NDE inspections by integrating additional specialist inputs into the decision process by methods such as telepresence, thereby better leveraging the scarce resources of senior inspectors into industrial inspections at multiple sites. The handbook also includes non technical topics of direct relevance to leadership management and adoption of this new philosophy. The handbook houses a wealth of essential information to help academics, industry professionals, regulatory bodies and entrepreneurs navigate through this burgeoning new field. The material in this handbook is presented with the intention of ultimately improving human safety through reliable inspections and dependable maintenance of critical infrastructure while also enhancing business value through reduced downtime, affordable maintenance and talent optimization. The content is positioned to inspire NDE professionals to think broadly in terms of their role as continuous value add rather than discrete decision support. This second edition contains many new chapters and half of all chapters were revised from the 1st edition based on the engagement of authors through global platforms such as the ICDNT Specialist International Group on NDE 4.0 and the International conference series on NDE 4.0.

**Catalog of National Bureau of Standards Publications, 1966-1976: Key word index** United States. National Bureau of Standards. Technical Information and Publications Division, 1978.

*Nondestructive Evaluation of Wood* Forest Service (U.S.), Forest Products Laboratory (U.S.), Robert J. Ross, 2015. Nature's engineering of wood through genetics: wind and weather creates a wide variability in wood as a material. Consequently, manufacture and users of wood products are frequently frustrated in dealing with the forest resource. Manufacturers sometimes argue that wood is difficult to consistently process into quality products because of the wide range of properties that exist in this raw material. Users of wood products can be equally frustrated with the performance variability found in finished products. Nondestructive evaluation (NDE) technologies have contributed significantly toward eliminating the cause of these frustrations. NDE technologies have been developed and are currently used in lumber and veneer grading programs that result in engineered materials that have consistent, well-defined performance characteristics. This brief volume explores some of the processes that are used to manufacture wood, including green wood technology, and provides a bit of history to wood production and its uses too. Other products that may interest you from the US Forest Service can be found at this link: <https://bookstore.gpo.gov/agency/819>.

*Computational Nondestructive Evaluation Handbook* Sourav Banerjee, Cara A.C. Leckey, 2020-06-01. Introducing computational wave propagation methods developed over 40 years of research, this comprehensive book offers a computational approach to NDE of isotropic, anisotropic and functionally graded materials. It discusses recent methods to enable enhanced computational efficiency for

anisotropic materials It offers an overview of the need for and uses of NDE simulation The content provides a basic understanding of ultrasonic wave propagation through continuum mechanics and detailed discussions on the mathematical techniques of six computational methods to simulate NDE experiments In this book the pros and cons of each individual method are discussed and guidelines for selecting specific simulation methods for specific NDE scenarios are offered Covers ultrasonic CNDE fundamentals to provide understanding of NDE simulation methods Offers a catalog of effective CNDE methods to evaluate and compare Provides exercises on real life NDE problems with mathematical steps Discusses CNDE for common material types including isotropic anisotropic and functionally graded materials Presents readers with practical knowledge on ultrasonic CNDE methods This work is an invaluable resource for researchers advanced students and industry professionals across materials mechanical civil and aerospace engineering and anyone seeking to enhance their understanding of computational approaches for advanced material evaluation methods      Composite Materials Isaac M. Daniel,1982      Electromagnetic Nondestructive Evaluation (XVI) J.M.A. Rebello,F. Kojima,T. Chady,2013-12-18

Electromagnetic Nondestructive Evaluation ENDE is the process of inducing electric currents magnetic fields or both within a test object to assess its condition by observing the electromagnetic response An important tool in fields as diverse as engineering medicine and art it does not permanently alter the object being tested thus proving invaluable for product evaluation troubleshooting and research This book presents the proceedings of the 17th International Workshop on Electromagnetic Nondestructive Evaluation ENDE held in Rio de Janeiro Brazil in July 2012 ENDE workshop is an important event for all scientists with interests in non destructive testing The first workshop took place in 1995 in London UK and has been followed by workshops held in various parts of the world but this is the first time this workshop series has come to a Latin American country The workshops bring together scientists and engineers active in research development and industrial applications of ENDE The book is divided into five sections advanced sensors analytical and numerical modeling systems and techniques for electromagnetic NDE characterization of materials and NDE of cracks and new developments and others Each section includes papers on a variety of subjects From the papers submitted for publication thirty six peer reviewed articles have been accepted six of which emanate from Latin American authors The book will be of interest to all those wishing to keep abreast of developments in the field or who rely on the advanced techniques based on electromagnetic principles applied to nondestructive evaluation in their work

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