



**ANNUAL
REPORT
2024**

Introduction

The Clemson Wood Utilization + Design Institute has had an active 2024 with various projects continuing and many projects set to start in the coming years. As the research, teaching, and outreach have continued, so too has mass timber construction on campus with work on the Nieri Family Alumni and Visitors Center which overlooks the 18th green on the shores of Lake Hartwell. In addition, construction of the replacement for Lehotsky Hall has begun and will heavily feature mass timber construction.

The following report outlines the contributions towards research, teaching, outreach, grant activity, and publications over the past year. In addition, many new grants and projects began in 2024 or are slated to begin in 2025. As the Institute continues its search for a new director, it is poised to continue to grow and support the wood industry.



A rendering of Clemson's newly constructed Nieri Alumni Center



A rendering of the Lehotsky Hall replacement building currently under construction



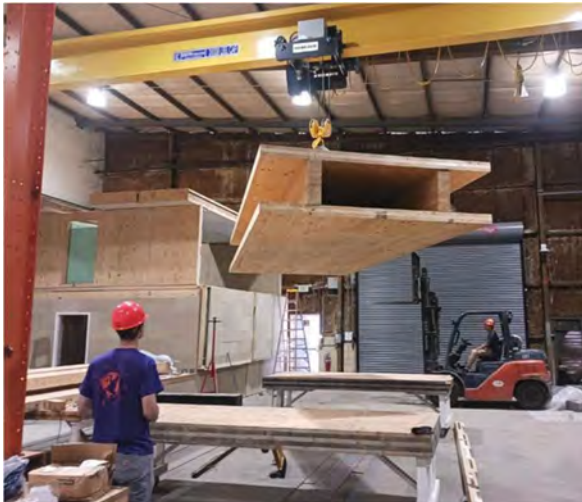
Architectural Activities

Architecture Contributions to ARPA-E Project

Dustin Albright, Kylee Russell, Britton Riddle, Coly Tabberson

This was the second full year for Clemson’s ongoing project titled: “An Entirely Wood Floor System Designed for Biogenic Carbon Storage, Adaptability, and End of Life De/Re/Construction.” The subject of the project is a long-spanning structural floor system consisting of 3-ply CLT flanges and glulam web members. These hollow floor cassettes are being designed for building systems integration, and for ease of assembly, disassembly and re-use of components. The project is being led by faculty and students from Civil Engineering, Environmental Engineering and Architecture, plus an industry advisory panel made of diverse professionals. It is being funded through the U.S. DOE’s Advanced Research Projects Agency - Energy (ARPA-E), under its [HESTIA program](#).

Among other contributions, the Architecture team has focused much of its attention on acoustic performance. Following the design and construction of a two-story acoustic testing chamber at our Built Environment Lab (BEL), several initial tests were performed on control floor assemblies for the purpose of validating the test setup. After validation, the team tested several different floor assemblies involving the experimental mass timber system. Testing followed applicable ASTM standards, including field test methods E336 (to measure the attenuation of airborne sound) and E1007 (to measure the attenuation of impact sounds). The timber floor cassettes performed well throughout and, with the addition of carpeting or an acoustic underlayment, were able to meet the stringent requirements set forward by the International Building Code for apartments, dormitories and hotels.



Lifting the experimental timber floor system into place and the subsequent acoustic testing within the two-story test chamber

In addition to the acoustic considerations, the Architecture team led the layout and modeling of a three-story baseline office building, which served as a vehicle for a life cycle assessment (LCA) study in which a conventional steel and concrete version of the structure was compared to a mass timber version which utilized our proposed floor system.

Post-Disaster Housing Studies

Dustin Albright, Elly Hall, Yongjia Song, Weichiang Pang, David Vaughn

2024 marked the third year of this interdisciplinary project, which was funded through NSF's Disaster Resilience Research Grants (DRRG) program. The project, titled "An Integrated Housing Design and Logistics Operations Modeling and Analysis Framework for Hurricane Relief," has been led by faculty members Yongjia Song (Industrial Engineering), Weichiang Pang (Civil Engineering), and Dustin Albright (Architecture), with additional support from David Vaughn (College of Engineering). The primary objective of the research is to investigate the effectiveness of a range of housing solutions in disaster relief and recovery by creating an integrated modeling and analysis framework for disaster housing logistics planning and operations.

The Architecture team continued examining case-studies of detached, post-disaster houses (alternatives to conventional FEMA units), this time with an emphasis on volumetric modular units designed for expansion. Once again, we have gathered data on unit costs, production capacities and timelines, logistics of delivery and installation, etc. Currently we are working on an integrated study in which the alternative housing units can be evaluated within the framework of demand modeling authored by the Civil Engineering team and the supply logistics analysis authored by the Industrial Engineering team.

Feasibility and Future Planning for the Port of Georgetown

Dan Harding

This initiative focuses on investigating optimal uses for the Port 31 site in Georgetown County. The grant is supported by a USDA Rural Business Development Grant and managed by the Clemson Community Research and Design Center. The research encompasses:

- Creative visioning and planning strategies
- Sustainable architectural approaches
- Applications of wood construction in coastal environments
- Economic development impact assessment

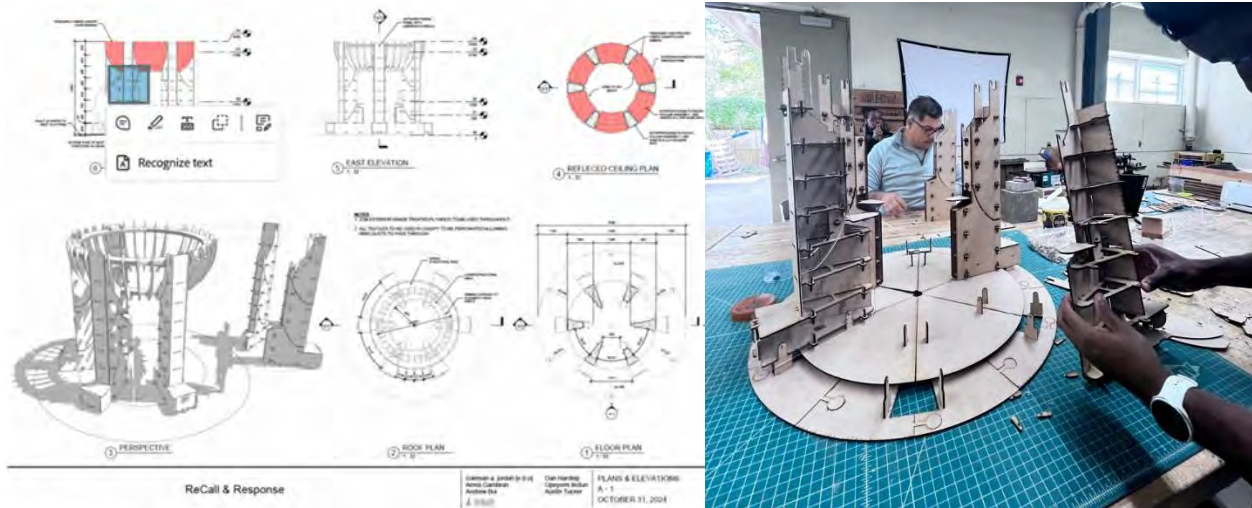


ReCall and Response – The Talking Drum Project

Dan Harding (with Coleman Jordan – Morgan State University)

The project leverages Clemson's expertise in wood construction, specifically utilizing the patented sim[PLY] framing system. The project is sponsored by the European Cultural Centre. Key components with wood structures fabricated at the Built Environment Lab (BEL) include:

- Specialized wood construction detailing
- Structural system development
- Prototype development and full-scale mockups
- Testing and assembly studies



Realizing Improved Patient Care through Human-centered Design

Dan Harding, Dustin Albright, Joel Brown

The project is funded by the Agency for Healthcare Research and Quality. It focuses on pediatric mental and behavioral health in emergency departments and utilizes the Sim[PLY] system with wood components fabricated at the Built Environment Lab (BEL) to create:

- Emergency Department Exam Room Mockup
- Convertible space designs for medical and behavioral health care
- Testing facilities at Prisma Greenville Memorial Campus

These initiatives represent significant advancement in:

- Sustainable architectural practices
- Cultural preservation and presentation
- Healthcare facility design
- Economic development in rural areas
- Innovation in wood construction techniques

The combination of these projects demonstrates a comprehensive approach to architectural innovation, combining practical application with research-driven methodologies.

Wood and Timber in Architecture Studio Courses

David Allison, Dustin Albright, Bradford Watson

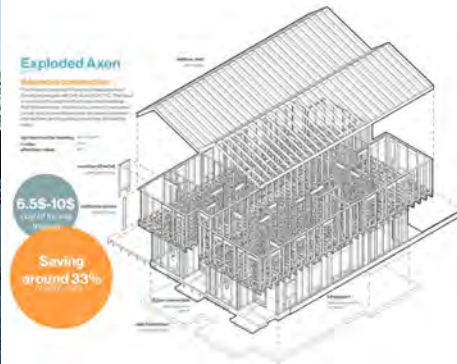
Design and construction with wood and timber continues to be a growing theme in design studio courses taught in the School of Architecture. Led by Professor David Allison in the Spring semester (2024), the Graduate Comprehensive Studio within our Architecture + Health concentration examined opportunities for mass timber in the design of a hypothetical Critical Access Hospital for Ely, Minnesota – a rural, medically-underserved community. The temperatures in Ely can range from the upper 70s to low 80s in July to well below freezing and as low as minus 20 or lower in the winter. Snow can occur beginning in mid-October through early May. Weather in the winter impacts access, construction, foundation design and snow loading on roofs. Mass timber was part of the resulting strategy to achieve resilient, energy-efficient designs for these conditions, while also minimizing embodied-carbon. The use of mass timber for healthcare and laboratory facilities is a fast-growing area of interest in the industry and in our Architecture + Health Program here at Clemson.



Exterior and Interior Renderings from Gateway to the Northern Lights project by Hsin-Cheng Chung

This Fall (2024), faculty members Dustin Albright and Bradford Watson have co-directed an upper-level studio titled: “At Home: Supporting Communities through Sustainable + Attainable Housing”. The joint studio was supported by a grant from Weyerhaeuser and was focused on affordable and workforce housing, with a particular emphasis on the use of sustainable wood building systems. Professor Albright’s class concentrated on in-fill and “missing-middle” scale housing for Greenville

County, SC, while Professor Watson’s class addressed midrise-multifamily housing on the Charleston, SC peninsula. Light wood framing (Albright) and mass timber / hybrid construction (Watson) were emphasized for the two studios, contributing to a holistic appreciation for the role of wood in low-carbon and energy-efficient structures.



Albright Studio: Townhouse Exterior Rendering plus Light Wood Advanced Framing Study by Daniel Montalvo



Watson Studio: Mass Timber Workshop with Visiting Scholar Jason Griffiths (UNL) plus Exterior Rendering by CJ Duff and Will Hough



In addition to the topical studio courses which emphasize the tectonics, performance qualities and sustainable attributes of wood, we continue to note broader interest from students, including applications in other studio coursework. The capstone Comprehensive Studio in our Master of Architecture program once again featured several projects in which students emphasized the use of mass timber for the structural system. This included a project by Kayla Pratt and Maddilyn Riester, titled “South Carolina Agricultural Education Center” (SCAEC), which has gone on to win a student honor award from AIA South Carolina and a student merit award at the regional AIA Aspire Conference.

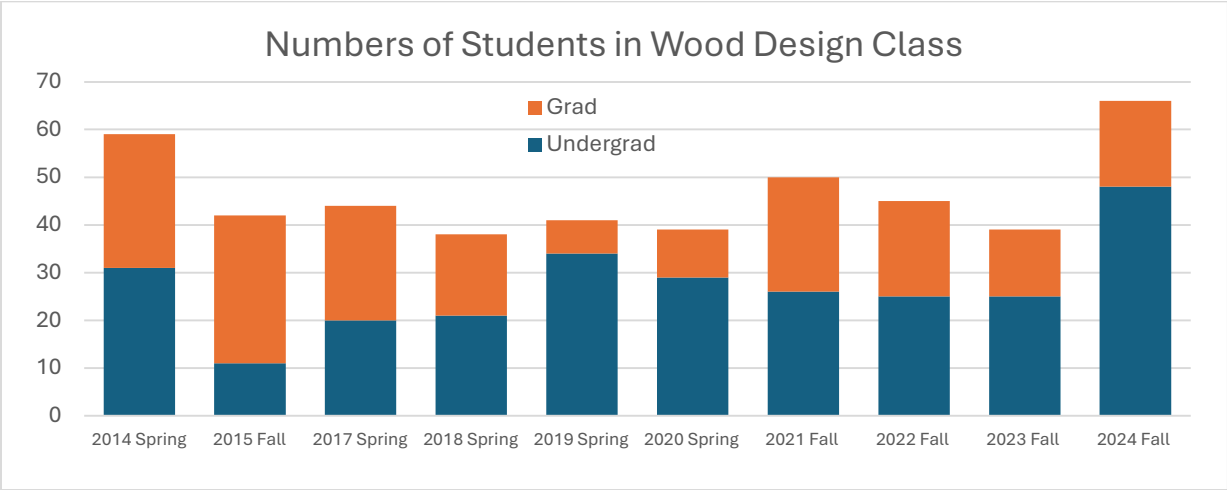


Exterior Rendering plus Section Perspective Drawing from SCAEC Project by Kayla Pratt and Maddilyn Riester

Engineering Activities

Wood Design Classes in Civil Engineering

Weichi Pang, Michael Stoner



The bar chart presents enrollment trends for the Structural Wood Design course from 2014 to the current academic year. In 2024, the course reached its highest enrollment in a decade, with 66 students participating (48 undergraduates and 18 graduate students). This milestone highlights the growing interest in wood design education. The course provides comprehensive instruction on the design of wood buildings and structures, adhering to the National Design Specification for Wood Construction (NDS). Since 2014, more than 460 students have completed the course, with an average annual enrollment of approximately 46 students.

A key factor in the course’s sustained popularity is the consistent support from Charles Ingram Lumber. Over the past nine years, Charles Ingram Lumber has generously supplied free copies of the NDS code to students, significantly enhancing the accessibility and appeal of the course. This sponsorship has solidified the Wood Design course as one of the most sought-after offerings in the Civil Engineering Department (see photo below). The ongoing support from Charles Ingram Lumber has been instrumental in fostering a dynamic and supportive learning environment, equipping aspiring engineers with the knowledge and tools necessary for careers in wood construction.



In addition to the Wood Design class offered in the Fall 2024 semester, a graduate civil engineering course focused on Advanced Wood Design topics was held for the first time at Clemson. In total, 8 graduate students (6 MS, 2 Ph.D.) were enrolled in the course which covered topics such as curved and tapered glulam beam design, mass timber design, fire design of mass timber structures, and the role of timber in the International Building Code. Students also experimentally measured the natural frequency of CLT beams (pictured) and compared them to theoretical equations. They also produced conceptual designs for mass timber gravity systems on a 5-story office building.



Graduate students participating in experimental vibration measurement of CLT panels

Timber Strong Design Build

Michael Stoner, Dylan Smith, Jack Grimes, and other undergraduate students



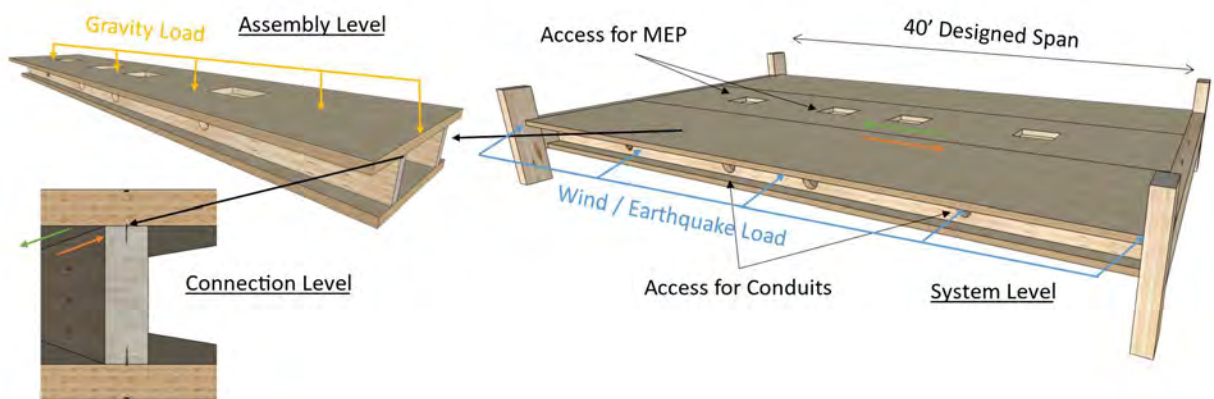
The Clemson Timber Strong Design Build team competed at an internal competition where they constructed a modular, 2-story, light-frame timber structure with various geometric and loading restrictions. Because the regional American Society of Civil Engineers Symposium did not host the competition, students built the structure in Clemson and judged it according to the provided rubric. The team has already started preparing for the 2025 competition and currently has a Creative Inquiry with 12 undergraduate students. As part of this year's competition, the students are required to design the two-story structure with a cantilevered second story as well as perform design calculations for all the structural members and connections (provided by Simpson Strong Tie) for vertical and lateral loading. The competition, where students construct, deconstruct, and present their final designs, will take place at Clemson University, April 10-12th, 2025.

Undergraduate students after the completion of the Timber Strong Design Build Competition construction

Ongoing Research: An Entirely Wood Floor System Designed for Biogenic Carbon Storage, Adaptability, and End of Life De/Re/Construction

Sovanroth Ou, Amin Nabati, Weichiang Pang, Michael Stoner, Brandon Ross

This research aims to develop and demonstrate an innovative floor system for buildings, enhancing the technical performance and market potential of mass timber. The proposed system addresses all phases of the building life cycle, including design, construction, occupancy, operation, and end-of-life material considerations. Key benefits include: (1) Biogenic Carbon Storage: Effective sequestration of carbon within the building materials, (2) Extended Structural Spans: Increased flexibility in architectural and structural design, (3) Service Integration: Dedicated channels for plumbing and other essential utilities, (4) Supply Chain Compatibility: Alignment with existing mass timber manufacturing and distribution networks, and (5) Deconstruction and Reuse: Construction techniques and detailing optimized for ease of disassembly and material reuse.



Conceptual design of the long-span mass timber system



Construction of the first of two, 40' span, mass timber systems tested in the summer of 2024 at the Built Environment Lab

In year on of the project, the team evaluated the mechanical performances of various glulam-to-CLT connections experimentally. In summer of 2024 (year 2 of the project), the research team constructed and tested the two composite floor assemblies. The glulam beams and CLT panels were connected via (1) adhesive and screws by Simpson Strong Tie in the first composite floor assembly,

and (2). Sharp metal plate and screws produced by Rothoblaas in the second composite floor assembly. Both specimens reached similar peak strength; however, the composite floor with sharp plate and screw is much more ductile. Furthermore, the two specimens were successfully deconstructed without any challenge even after loading them to failure.

Another highlight of the summer was hosting six undergraduate interns, representing Clemson University, Swarthmore College, The University of Nevada Las Vegas, and Washington and Lee University. The interns, along with graduate students, played a critical role in building and testing the assembly specimens.



Graduate students, undergraduate interns, and faculty standing on a floor specimen after a successful load test.

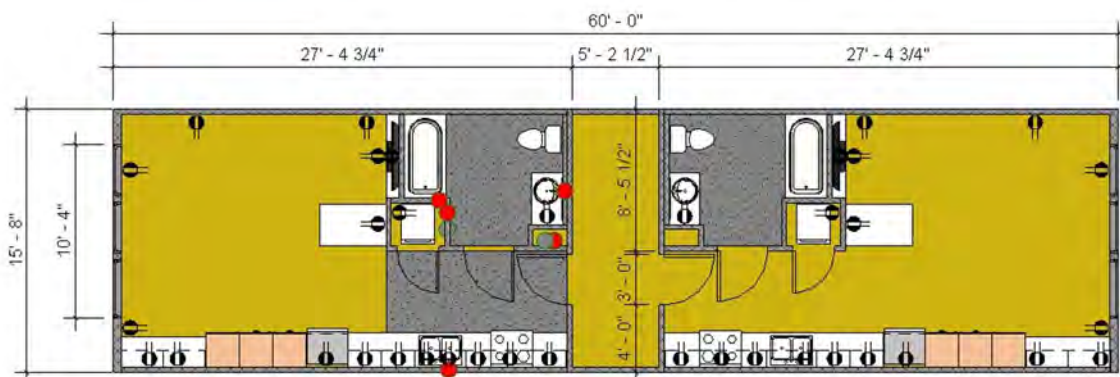
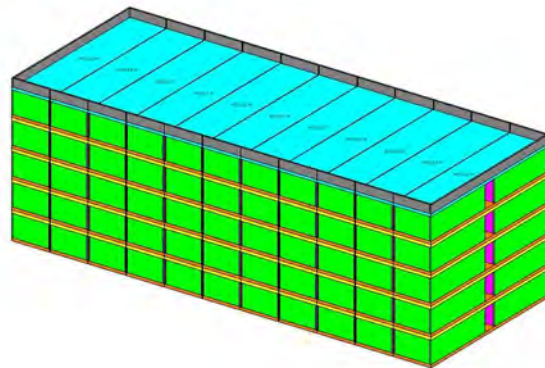
Ongoing Research: Optimization of Hybrid Mass Timber Structure for Carbon Positive Affordable Housing

Abdulrahman Abdullahi, Weichiang Pang (in Collaboration with Arezou Sadoughi at Appalachian State University)

This research began in Fall 2023. The research seeks to design, construct, and promote Hybrid Mass Timber (HMT) structures to deliver high-quality, cost-effective housing while providing workforce training resources. HMT structures integrate mass timber with industrialized construction techniques, enabling scalable production and addressing challenges associated with mass timber adoption. By optimizing the hybridization of mass timber and standard framing systems, the project aims to reduce production time for modular affordable housing, making it more accessible and practical for widespread use.

The project focuses on two primary objectives. First, it aims to develop design guidelines for mass-produced HMT structures and construct a demonstration unit that showcases its capabilities. This unit will serve as a tangible example for prospective clients, offering opportunities for tours, inspections, and evaluation. Additionally, the project addresses on-site installation challenges by eliminating the need for ceiling gypsum, streamlining factory-based mechanical, electrical, and plumbing (MEP) installations, and minimizing labor-intensive finishing tasks. These advancements are supported by advanced fabrication-aware design tools to ensure efficient factory processing.

Second, the project aims to quantify the added value of HMT structures through cost optimization, life cycle assessments (LCA), and life cycle cost analyses (LCCA). By aligning with the 2021 building codes, this initiative represents a significant step forward in leveraging HMT structures for sustainable construction and advancing the wood circular economy. This innovative approach not only supports the production of affordable housing but also promotes sustainable practices and enhances the economic viability of hybrid mass timber solutions.



Ongoing Research: Moisture Monitoring of CLT Noise Barriers

Weichi Pang, Laura Redmond, Pat Layton, Michael Stoner

Two 3-ply CLT noise barriers have been continuously monitored for fluctuations in moisture content and degradation in visual appearance. The first barrier was constructed in August 2021 with two coatings meant to prevent UV degradation, discoloration, and promote water repellency. The second barrier was constructed in December 2023 without any additional coating. The panels perform similarly regarding their moisture performance with peaks after rainfall events and a return to normal moisture within 10 hours. The changes to the panel's appearance are shown with some delamination occurring in the first barrier at the top where there was a small strip of wood. Changes in color for both barriers can be seen over the past year. The barriers will continue to be monitored for their fluctuations in moisture and change in appearance.



Construction of the first CLT noise barrier in August 2021 (left) and currently (right) with two UV coatings



Construction of the second CLT noise barrier in December 2023 (left) and currently (right) with no coating

Ongoing Research: Creep Measurement of CLT Panels

Weichiang Pang, Michael Stoner

A total of six CLT panels have been continually monitored as they creep under sustained loading. A set of two CLT panels were tested to failure in bending to establish the peak moment capacity. The stacks of CLT are loaded between 14% and 30% of the peak capacity and monitored both continually with digital measurements and weekly with manual measurements. The average creep ratio (current deflection/initial deflection) matches well with the current recommendation of the National Design Specification. A majority of the creep occurred within the first 100 days of loading with minimal increases in the past year. Fluctuations in the creep continue to occur with a significant decrease in creep corresponding to a drop in temperature (and loss of power/air conditioning) in December 2023. Continued monitoring of the panels will occur throughout the next year.



Creep setup with three stacks of CLT and GLT members loaded and instrumented to measure deformation (creep)

Ongoing Research: Cost-effective screening, assessment, and repair of timber piles in South Carolina

Brandon Ross, Thomas Cousins, Weichiang Pang, Brunela Pollastrelli Rodrigues, Aashish Sapkota

There are approximately 75,000 timber piles supporting rural bridges in South Carolina. Many of these piles are decades old. Under federal law, all bridge components, including timber piles, must be inspected biannually. This SCDOT-funded project kicked off last summer with the goal of improving the efficiency and effectiveness of pile inspections. Members of the Institute have teamed with collaborators at the University of South Carolina.

Initial work has focused on getting the research team up-to-speed on current pile inspection procedures and to create an SCDOT “wish list” for process improvements. The team has interviewed SCDOT personnel and engineering consultants involved in pile inspections. They also rode along during bridge inspections to observe current inspection procedures.

Recent efforts included collecting and documenting timber piles salvaged from bridge replacement projects around South Carolina. Eventually, a battery of non-destructive, semi-destructive, and destructive evaluations will be performed on the pile specimens. Future plans also include field testing novel and established evaluation technologies, developing tools for quickly incorporating inspection results into structural capacity estimates and training with SCDOT personnel and bridge inspection consultants.



Timber piles supporting a bridge in Greenwood County, South Carolina. These piles were salvaged for research when the bridge was deconstructed and replaced.

Forestry Activities

Revitalizing FEC Wood Collection

Brunela Pollastrelli Rodrigues

The Department of Forestry and Environment Conservation (FEC) has a small wood collection with approximately 2,000 specimens. We used best practices of wood collection, curating and wood identification to sort, inventory, and digitalize the department's wood collection. This initiative will enhance our teaching, research, extension, and service.

Some interesting facts found about the collection:

- Approximately 2,000 samples
- 765 different species
- 408 different genera
- 105 different families
- 94% of the samples are identified at the species level
- 6% are identified only at the genus level
- Approximately 60% originate from North America
- Approximately 40% originate from South America, Central America, Africa, Asia, Europe, and Oceania.

It highlights the diversity of the wood specimens, indicating the potential of the collection to be used by the Clemson community and other stakeholders.



Dr. Coitinho, a visiting scholar from the University of Viçosa, Brazil, sorting and organizing wood collection samples

Bridging Academia and Industry: Students Hands-On Learning at Summer Camp 2024

Brunela Pollastreli Rodrigues

Forest Resource Management students attending the 2024 Forest Products Summer Camp course, taught by Brunela Pollastreli Rodrigues, had the chance to travel across South Carolina and Georgia, visiting forest products facilities to learn about a range of forest products produced in the Southeast. The students had the unique opportunity to engage with industry leaders and wood procurement foresters at the following companies: Clendenin Lumber (Baillie group), West Fraser, Enviva, Stella-Jones, Boise Cascade, Roseburg, CANFOR, Huber Engineered Woods, and International Paper. Students learned about sustainable practices, wood processing, cutting-edge technologies, and the diverse applications of wood as a renewable material. Big thanks to all the companies!



Students attending the 2024 Forest Products Summer Campe at various locations across South Carolina and Georgia

Wood Quality: from cells to their final utilization

Brunela Pollastreli Rodrigues

Have you ever wondered why some wood species are used for some special applications while others can have multiple applications?

Offered by the Department of Forest and Environmental Conservation, the Applied Wood Quality course taught by Dr. Brunela Pollastreli Rodrigues covers all aspects of wood as a biological material, from wood formation to its final application. By the end of this course, graduate students demonstrated knowledge of how wood quality is required for different uses and applications and gained expertise in assessing wood quality for different uses.



Grad students – Anjila Lamichhane (PhD Forest Resources) and Aashish Sapkota (MS Civil Engineering) – studying wood specimens during the Applied Wood Quality course.

Nondestructive Methods Demonstration

Brunela Pollastreli Rodrigues

The senior "Problems in Forestry" class offered by Brunela Pollastreli Rodrigues welcomed Jonathan Simmons, a Clemson Forestry and Environmental Conservation alumnus from the Arbor Source company for a demonstration of nondestructive methods, tomography and resistography. These techniques can be used to assess internal defects, voids, and decay in trees, wood beams, columns, poles, and piles.



Zoe Fair (FEC-Clemson University senior student) and Jonathan Simmons (Arbor Source Arborist) conducting the assessment of a trunk sample.

Partnerships for Climate-Smart Commodities

Pat Layton

Clemson University received a large grant from the USDA Natural Resources Conservation Service as part of their Partnerships for Climate-Smart Commodities Projects. While most of the funding went to agriculture in SC, a significant amount is aimed at forest practices and products. Pat Layton serves on the Forestry Marketing Team of the grant entitled Climate-Smart Grown in SC.



The Forestry Marketing Team works on three main facets of marketing Climate-Smart Forest products. These facets are 1) to determine forest owners' motivations, considerations and willingness to accept adopting Climate-Smart Forest (CSF) practices; 2) the forest industry's considerations in processing and selling Climate-Smart Forest products; and 3) consumers' willingness to pay for Climate-Smart Forest products. To determine the forest owners' willingness to accept, 3,000 surveys were mailed to SC forest owners. Most forest owners pointed to financial incentives as the primary motivation for adopting CSF.

The industry surveys will be designed and distributed to primary and secondary mills, loggers, wood buyers, wholesalers, and CLT companies next year. We will ascertain the forest industry's motivations and barriers to adopting traceability of the Climate-Smart Forest products.

Consumers' knowledge of climate change, purchasing behavior, preferences for Climate-Smart Forest products, awareness and perception of Climate-Smart Forestry, and willingness to pay for the traceability of forest products using blockchain technology will be tested in the subsequent phases of this project.

We are developing a forest management certification protocol for the Climate-Smart Forest products via collaboration with Innovative Forestry Investments, LLC. We are collaborating with the US Endowment for Forestry and Communities, Chainparency, and the Longleaf Alliance to track and trace the wood from these forests. Our first pilot test is ongoing as we track wood from the Norfolk Southern Brosnan Forest to Collum's Lumber Products LLC, to SmartLam NA and then Clemson University, where the wood will be used in a building.

<https://norfolksouthern.mediaroom.com/2024-10-24-Norfolk-Southern-Brosnan-Forest-Provides-Timber-for-New-Academic-Building-at-Clemson-University>

Outreach Activities

ASCE/SEI Wood Education Committee



Weichi Pang was elected Chair of the American Society of Civil Engineers (ASCE) and Structural Engineering Institute (SEI)'s Wood Education Committee in Fall 2024. His three-year term will run from October 2024 to October 2027. The committee's mission is to promote and enhance structural wood engineering education in both academic and professional contexts. To achieve this, the committee focuses on: (1) developing educational resource materials and teaching tools; (2) organizing national-level instructional programs in wood engineering; and (3) fostering wood design competitions for civil engineering students.

This leadership role reflects the commitment to advancing wood engineering education and inspiring future civil engineers to explore sustainable and innovative wood construction solutions.

Timber Education Workshop at Cal Poly Pomona

Weichi Pang was invited as a guest speaker and an instructor for the Timber Education Workshop at Cal Poly Pomona, held from October 17 to 19. The workshop was sponsored by the Softwood Lumber Board (SLB) and it addressed the critical gap in timber education within undergraduate and graduate Civil Engineering programs, where wood-related courses are either non-existent or limited in approximately 50% of institutions.

Designed to empower university faculty to integrate timber design into their curricula, the workshop provided tools, resources, and guidance from experts with decades of teaching and research experience. The program included an overview of successful course offerings at Cal Poly Pomona, spanning over four decades, and featured the widely-used Design of Wood Structures textbook by Donald E. Breyer and co-authors. As a guest speaker and instructor, Weichi Pang contributed to this important initiative, supporting the advancement of timber education in Civil Engineering.

TIMBER EDUCATION WORKSHOP

October 18-19, 2024

HOSTED BY:



SPONSORED BY:



SUPPORTED BY:



PRESENTED BY:

YOUR HOST Structural Engineering		Mikhail Gershfeld, SE Practice Professor CPP TDI Senior Advisor
FOREST Forestry, Wood Science		Edie Hall, PhD Three Trees Consulting
RESEARCH SUPPORT Architecture, Engineering, Wood Science		Iain MacDonald Director TDI Collaboration of UO College of Design, and OSU College of Forestry and Engineering
DESIGN/EDUCATION Architecture		Judith Sheine UO Professor Director of Design TDI
RESEARCH/EDUCATION Structural Engineering		Andre Barbosa, PhD OSU Professor Cecil and Sally Drinkward Professor in Structural Engineering
RESEARCH/EDUCATION Structural Engineering		Weichi Pang, PhD Clemson University Professor Professor of Intelligent Infrastructure

Appalachian Hardwood Conference/Southern Group of State Forester's SUM meetings

Pat Layton attended the Appalachian Hardwood Conference and the Southern Group of State Forester's SUM meetings in Florida. At both meetings, Layton was able to speak briefly about the importance of new markets for southern forest products and the need to move forward with mass timber but also to look for other new markets for small wood (i.e., pulpwood) as pulp mill closures were likely to cause issues for forest landowners.



North American Biochar Conference

Pat Layton attended the North American Biochar Conference in Sacramento, California, in February. There are several opportunities for new products that can come from biochar, including additives to concrete and sheetrock (gypsum board). From the viewpoint of utilizing wood (and ag residues) in our state, the size and opportunities for this market are very attractive. We have the wood; the pricing for wood in SC is very economical compared to other parts of the country, and we have several industries that could use biochar in their manufacturing. The key may be to attract several large biochar production facilities. Many of the ones we met in California were open on a small scale. Can they begin small and grow large? Or can they be distributed near manufacturing sites that will use their biochar to reduce transportation costs? And finally, how does Clemson University help?



International Mass Timber Conference

In March, WU+D faculty fellows and graduate students again participated in the International Mass Timber Conference in Portland, Oregon. The event was very successful again this year. Graduate students enjoyed a tour of the Portland Nut and Bolt company. There, they learned how bolts and connectors are made for projects.



Clemson faculty and students at the WU+D booth attending the International Mass Timber Conference in Portland, OR

Bioeconomy Trade and Study Mission: US, Canada, and Finland sponsored by Business Finland

Pat Layton was invited to attend (with others) a mission sponsored by Business Finland. The Bioeconomy Trade and Study Mission from the US and Canada to Finland included about 60 people, including our hosts. From SC, State Forester Scott Phillips joined me, and from WU+D Institute membership, we were joined by Matt Edwards from Weyerhaeuser Corporation. Representatives from Nova Scotia, Washington, Minnesota, Michigan, Alabama, Georgia, Maine, Colorado, and Arkansas attended. Finland has no fossil fuels or almost no non-renewable resources and has focused on a Sustainable Bioeconomy. Instead of being dependent on importing all things, they have focused on caring for their relatively small population and becoming a large exporter of all they can produce from wood, their most abundant resource. As a country, they invest in R&D with their industries and universities to grow the number and type of products they can use and export. They have taken full advantage of their ability to use EU funds to do the same.



Pat Layton with Doug Hickey, US Ambassador to Finland



Michaela Harms and Pat Layton at the Mass Timber/Massive Cooperation event in Detroit, MI

Mass Timber/Massive Cooperation

Pat Layton participated in the Mass Timber/Massive Cooperation event in Detroit, MI, on Thursday, September 19, 2024. Layton spoke about the forests in the US that produce the products used in Mass Timber. She was joined by Michaela Harris, Senior Director of Mass Timber for Sterling Site Access Solutions, who spoke about their manufacturing and building processes. The symposium was part of Detroit Month of Design and was cosponsored by Gensler and Lawrence Technological University's College of Architecture and Design.

Sustainable Future of CLT in the South: Grow. Design. Build

In October, Auburn University held a cross-laminated timber (CLT) conference entitled “The Sustainable Future of CLT in the South: Grow. Design. Build” on October 7-9, 2024. On October 8, 2024, Pat Layton participated in the University Research Panel, along with David Hinson, FAIA, Associate Dean, College of Architecture, Design and Construction at Auburn; Peter MacKeith, Dean and Professor, Fay Jones School of Architecture, University of Arkansas, and Judith Sheine, DPACSA, Professor, School of Architecture & Environment, College of Design, University of Oregon | Director of Design, TallWood Design Institute. Richard Vlosky, Louisiana Tech, moderated the panel.



Pat Layton participating in the panel focused on CLT research at universities

Mass Timber Solutions Conference – NC State

North Carolina State University hosted the Innovation in Mass Timber Solutions Conference on October 28-29. The Innovation in Mass Timber Solutions (IMTS) was a two-day conference that gathered experts, including WU+D Director Pat Layton, from across industry and academia to provide an experience that engages participants in the exploration of the development and application of mass timber and cross-laminated timber. NC State wants to develop a path forward in mass timber research and teaching.

Forestry Association of SC

Pat Layton attended the Forestry Association of SC meeting in November and the Mass Timber Plus Conference. During the Mass Timber Plus conference, she toured the University of Pennsylvania’s Amy Guttman Hall and the Edelman Dinosaur and Fossil Museum in New Jersey. Both buildings are worthy of tours. The Dinosaur and Fossil Museum will open in March and was worth a family visit for all.



SLB Architecture Workshop – Summer 2024

Clemson’s School of Architecture and Clemson’s Wood Utilization + Design Institute (WU+D) partnered with the Softwood Lumber Board (SLB) and the U.S. Endowment for Forestry and Communities to host a two-and-a-half-day workshop for architecture faculty from around the country. The 2024 version of our Timber Design Faculty Development Workshop was held May 20-22 and featured presentations, building tours, a guided visit to Clemson’s Experimental Forest, and a hands-on look at ongoing research being conducted at Clemson’s Built Environment Lab (BEL). The aim was to educate attendees about advanced and emerging timber design with a particular focus on “mass” timber and strategies for incorporating this subject matter into their teaching, research and outreach.

A diverse group of twenty architecture faculty members, all from different institutions across the U.S., participated in the workshop. Their motivations for attending were varied, as were their levels of prior knowledge about mass timber and its applications. Some had been teaching in the area of sustainable design and high-performance buildings and wanted to form stronger connections to the critical role that timber systems can play in decarbonizing our environment. Many were early-career academics looking to learn from “emerging pedagogical approaches” that could be readily applied to their own teaching and scholarship.

Presenters from Clemson included Dustin Albright (Associate Professor, Architecture), Pat Layton (WU+D Institute Director), Weichiang Pang (Professor, Civil Engineering), and Michael Stoner (Lecturer, Civil Engineering). Invited guest presenters included James Michael Tate (Associate Professor, Texas A&M School of Architecture), Jason Griffiths (Associate Professor, University of Nebraska-Lincoln College of Architecture), and Jessica Scarlett (WoodWorks Regional Director).

Included among the feedback we received from participants following the workshop, Jordan Kanter

(Assistant Professor, UMass Amherst Dept. of Architecture) had this to say: “This was an exceptionally informative, well-organized workshop. It introduced a range of cutting-edge approaches in mass timber, engaged the topic through a multidisciplinary lens, and most importantly, provided the opportunity to connect with a group of academics from across the country with a shared interest for timber in design practice, research, and teaching.”



Participants in the 2024 SLB Architecture workshop at Clemson University

Advanced Research Projects Agency – Energy (ARPAe) Summit

Clemson sent Muzan Williams, Colton Moreno, and Brandon Ross to the ARPAe Summit in Dallas, TX on May 22-24. The summit was an opportunity to showcase the work done by the sponsored project focused on the development of a mass timber floor system with long span potential. It was an opportunity for Muzan and Colton to discuss their work with a broad audience of people from experts in the field to those curious about the potential for mass timber. The successful trip to the summit was a valuable experience and the project team looks forward to participating again in 2025.



Clemson hosts CUTEK® for a demonstration at the Quattlebaum building

On June 25, Clemson hosted CUTEK® at the Quattlebaum along with WU+D fellows and Clemson Facilities to view CUTEK® products and discuss ongoing research related to wood durability. The team saw samples of the products applied to Southern Yellow Pine CLT as well as toured the Built Environment Lab and saw ongoing studies of the CLT noise barriers.

Grants & Contracts

New for 2024

“Development of De/Re-deployable Mass Timber Tactical Shelter for ACE Environment,” U.S. Air Force, \$843,235, (2024-2026).

“Housing Design Studio,” Weyerhaeuser, \$30,000, (2024-2025).

“Development of Engineering Wood Design Class Teaching Materials for Educators,” Softwood Lumber Board, \$52,227 (2024-2024)

“Timber Design Architecture Faculty Development Workshop,” Softwood Lumber Board, \$48,251 (2024-2024).

“Development and Promotion of the Market for Timber in Industrial Facilities”, United States Department of Agriculture, Forest Service (FS), \$300,000 (2024-2029).

“Optimization of Hybrid Mass Timber Structure for Carbon Positive Affordable Housing,” United States Department of Agriculture, Forest Service (FS), sub-award through Appalachian State University, \$300,000 (\$90,000), (2024-2026).

“Developing All-Wood Nail-Laminated Timber Panel Systems for the U.S. Affordable Housing,” United States Department of Agriculture, Forest Service (FS), sub-award through University of Maryland, \$200,000 (\$100,000) (2025-2027).

“Effective Screening, Assessment, and Repair of Timber Piles,” South Carolina Department of Transportation, \$850,034, (2024-2027)

Ongoing or Completed

“Building Partnerships for Climate Smart Commodities in SC,” USDA, WU+D portion: \$100,000 (2022-2024).

“An Entirely Wood Floor System Designed for Biogenic Carbon Storage, Adaptability, and End-of-Life De/ Re/Construction,” U.S. Department of Energy, \$1,042,934, (2022-2025).

“The Clemson Mass Timber Structure Training Program,” USDA Forest Service, \$128,093, (2022-2025).

“Mass Timber Reconstruction of a High-Profile Academic Building at Clemson University: Lehotsky Hall,” USDA Forest Service, \$250,000, (2022-2025).

“An Integrated Housing Design and Logistics Operations Modeling and Analysis Framework for Hurricane Relief,” National Science Foundation, \$399,999, (2021-2023).

“Enable the Use of Mass Timber Products for Non-Residential Buildings in High Velocity Hurricane Zone,” United States Department of Agriculture, Forest Service (FS), \$249,999, (2019-2022).

“Development and Promotion of Mass Timber Noise Barriers for Highways,” United States Department of Agriculture, Forest Service (FS), \$248,809, (2019-2022).

“Integrated Housing Design and Logistics for Disaster Relief,” USDA, Forest Products Laboratory, \$50,000, (2019-2021).

“Full-scale testing of cross-laminated timber diaphragm in-plane shear and development of a design guide for practitioners,” United States Endowment for Forestry and Communities, \$305,000, (2017-2022).

Publications and Presentations

Publications:

*Bhardwaj, B., Pang, W., Stoner M., (2024). Experimental Investigation of the Repairability of a Cantilever Cross-Laminated Timber Diaphragm. *Journal of Performance of Constructed Facilities*. 35(5), <https://doi.org/10.1061/JPCFEV.CFENG-4757>

Bhardwaj, B., Pang, W., Stoner M., Rammer, D., & Pryor S. (2024). Experimental characterization of cantilever cross-laminated timber diaphragms under in-plane shear load. *Journal of Structural Engineering*, 150(2). <https://doi.org/10.1061/jsendh.steng-12590>

Satterlee, D. L., Hiesl, P., Smidt, M., Hagan, D. L., Watson, E., Gregory, L., Pollastrelli Rodrigues, B. (2024). Comparing Wood Chip Quality from Different Sources across the Southeastern United States. *Forest Products Journal*, 74(2), 178-184. <http://dx.doi.org/10.13073/fpj-d-24-00011>

Hiesl, P., Pollastrelli Rodrigues, B., Swecker, B., Steele, J., & Visbisky, J. (2024). Using Your Portable Sawmill to Cut Stickers for Lumber Drying. Land-Grant Press by Clemson Extension. <https://lgpress.clemson.edu/publication/using-your-portable-sawmill-to-cut-stickers-for-lumber-drying/>

**Ravindran, P., Owens, F. C., Costa, A., Rodrigues, B. P., Chavesta, M., Montenegro, R., Shmulsky, R., Wiedenhoef, A. C. (2023). Evaluation Of Test Specimen Surface Preparation On Macroscopic Computer Vision Wood Identification. *Wood and Fiber Science*, 55(2), 176-202.

Li A., Krol R., Henderson A., Soltangharai V., Ross B., Cousins T., Ziehl P., (2024) "Enhancing the rehabilitation of timber piles using fiber reinforced polymer: An acoustic emission analysis under compressive stress" *Construction and Building Materials*. <https://www.sciencedirect.com/science/article/pii/S0141029624014779>

Becker, A., Ross, B., Albright, D. (2023). Comparing Design Features of Campus Buildings with Adaptation/Demolition Outcomes. *Journal of Technology | Architecture + Design (TAD)*, volume 7, issue 2 (2023): 192-203. <https://doi.org/10.1080/24751448.2023.2245716>

*Winner of the Editor's Choice section of the *Journal of Performance of Constructed Facilities*

**Winner of the 2024 George Marra Award for excellence in research and writing (The Marra Awards were created to honor George Marra, a prominent member of the wood science community for many years and president of the Society of Wood Science and Technology (SWST), at his untimely death in 1983. George was a champion of quality in writing and this prestigious annual award recognizes excellence in research and writing within those papers published in each volume of *Wood and Fiber Science* journal.)

Presentations:

Stoner, M. "An Introduction to Mass Timber as a Sustainable Building Material," Sustainability 1010, Clemson, SC. (March 14, 2024).

Albright, D. "Comparing Design Features of Campus Buildings with Adaptation/Demolition Outcomes," 112th ACSA Annual Meeting, TAD Journal Session. Vancouver, BC. (March 15, 2024).

Ross B., "Answers to Four Questions about Buildings and Design for Adaptability (DfA)," Invited Lecture, Virginia Tech, Charles E. Via Department of Civil and Environmental Engineering, (April 2024).

Layton, PA. 2024. Invited Panel Member on the Urban and Community Forestry Standard developed by SFI. June 5, 2024. Atlanta, GA.

Layton, PA. 2024. Welcome Presentation. Forest Health Meetings. Greenville, SC. June 16, 2024.

Ross, B., Albright, D., Kane, M. "Mass Timber and Open Buildings: Reducing Carbon While Planning for Flexible Futures," Online presentation to the Council on Open Building. (July 23, 2024).

Cansler, N., "Shear Performance of Timber-to-Timber Structural Connections with a Focus on Strength, Stiffness, Deconstruction, and Sustainability", Poster Presentation, Clemson University Summer REU, (July 24, 2024).

Layton, PA. 2024. Invited Panel Member on Mass Timber. AIA Tennessee. Knoxville, TN. August 8, 2024.

Layton, PA. 2024. Results of the Clemson University Pilot Project on the SFI Urban and Community Forests Standard. Presented at Workshop on the Urban and Community Forest Standard. Atlanta, GA. August 10-11, 2024.

Pollastreli Rodrigues, B. A Review of Ground Penetrating Radar for Inspecting Wood Structures. 23rd International Nondestructive Testing and Evaluation of Wood Symposium. Campinas, São Paulo, Brazil. (September 17-21, 2024).

Pollastreli Rodrigues, B. Understanding the base material: trees. Workshop on urban tree evaluation and monitoring. 23rd International Nondestructive Testing and Evaluation of Wood Symposium. Campinas, São Paulo, Brazil. (September 17-21, 2024).

Layton, PA. 2024. Building Sustainably with Wood. LTU Mass Timber Symposium. September 19, 2024. Detroit, Michigan.

Layton, PA. 2024. University Research Panel. The Sustainable Future of CLT in the South: Grow. Design. Build. October 8, 2024. Auburn, AL.

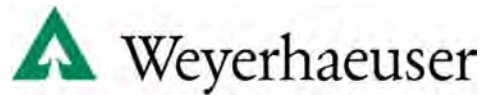
Layton, PA. 2024. Mass Timber and Building a Multidisciplinary and Multifaceted Research Initiative. An invited presentation to NC State University's Innovation in Mass Timber Solutions Conference. October 29, 2024.

Layton, PA. 2024. Building with Mass Timber. Episode 306 of Resources Radio, a weekly podcast from Resources for the Future. November 5, 2024.

Layton, PA. 2024. Moderated panel on Amy Gutmann Hall, A Case Study in Mass Timber Constructability – Home of Data Science & AI for Penn Engineering. November 13, 2024.

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