Technical Session 2:
Colley/Hartford Memorial Lecture and Research Symposium

2022 Colley/Hartford Memorial Lecture
Wood Architecture – Current Trends in Mass Timber and Thoughts About Exposing Wood

Dr. Uli Dangel
University of Texas at Austin

ABSTRACT
Faced with human-made climate change and the need to provide housing for a growing world population, society needs to rethink how future buildings are made. Wood is a truly renewable building material that is unlimited in supply if its growth and harvest are sustainably managed. Recent technological advancements in engineering allow the use of timber for the construction of mid- and high-rise structures. Mass timber products can offer alternatives to the more energy-intensive building materials steel and concrete, turning buildings into carbon sinks rather than becoming sources of C02 emissions. This paper presents arguments and case studies that demonstrate how the increased use of wood can positively impact the environment, local economies, and the building culture at large. Driven by the increased use of wood in the construction sector, it also addresses thoughts on best practices about exposing wood in exterior architectural applications.

Plant Polyphenolic Extracts as Natural Pesticides for Wood Protection Treatments

Jean-Paul Joseleau , Daouia Messaoudi, and Katia Ruel
Berkem

ABSTRACT
Because of its susceptibility to biodegradation by fungi, by insects, and by abiotic factors, wood must be protected with biocide treatments. Treating wood materials against deterioration is of particular importance for construction in indoor and outdoor environments to bring them resistance and durability. Conventional treatments using synthetic pesticide products have harmful impact on environment, and adverse effects on health such as toxicity and carcinogenicity. Therefore, the demand for new pesticide formulations more respectful of the environment is high. In this context, R&D Laboratories of Groupe Berkem has developed new ecologically friendly waterborne formulations meeting the legislation requirements for sustainable wood material protection.

This new generation of polyphenol-containing formulations, with over 80% bio-based waterborne formulations with minimal concentrations of active agents beside polyphenol compounds, was tested on various substrates. They showed effectiveness on Scots pine (Pinus sylvestris) sapwood and other wood-containing substrates, preventing deterioration by subterranean termite species and by a house long-horned beetle. After 1 to 3 months of exposure to the termites, all the treated specimens showed total protection. The action of the polyphenol-enriched formulations at low concentration was also demonstrated in preventing growth of the dry rot Serpula lacrymans on masonry wood and against several types of lignolytic fungi on Scots pine.
Our waterborne preservative allowed reducing the concentrations of the active chemical agents by a factor of 20. All these results underscore the interest of our formulations with low environmental and security impact.

Advances in Cottonseed-Guayale Research as a Bio-Based Adhesive for Hardwood Plywood

Edward D. Entsminger, Dercilio J.V. Lopes, Ramon F. Oliveira, Gabrielly dos Santos Bobadilha, Rubin Shmulsky, and Michael K. Dowd
Mississippi State University

ABSTRACT

This research focuses on the production of value-added wood products from upland cotton (Gossypium hirsutum) and guayule (Parthenium argentatum) plants. Literature indicates that the cottonseed protein meal can be used as an environmentally safe and friendly, bio-based, formaldehyde-free wood-based adhesive. Harvested guayule woody biomass is ground into bagasse (a fine fibrous wood pulp byproduct) from which solid latex rubber is chemically extracted, leaving a guayule resin byproduct. Research shows that guayule resin has the potential as low-toxicity components of coatings, tackifiers, adhesives, emulsifiers, bio-control agents, insecticides, antimicrobials, and antifungals. Guayule has demonstrated performance as a natural biocide (termiticide and fungicide). This research focused on adding a guayule resin-acetone solution to a cottonseed meal adhesive formulation to produce three-ply yellow poplar (Liriodendron tulipifera) plywood. Three adhesives were prepared such as a 53% protein cottonseed meal, cottonseed-guayule-acetone adhesive, and a 49% protein soybean meal. Commercially manufactured soybean adhesive bonded with yellow poplar hardwood plywood panels were also purchased and tested for comparison. Each protein meal was mixed with deionized water, sodium metabisulfite (Na2S2O5), and a polyamido-amine-epichlorohydrin (PAE) as a wet strength agent. The plywood panels were hot pressed for 6 minutes at 135°C (275°F) at a constant pressure of 1.24 MPa (180 psi). Then each panel was processed into four different test regimes to conduct mechanical shear strength, water resistance, fungal decay resistance, and termite resistance as per national and international standards. Preliminary results show similar water resistance and mechanical shear strength to each of the cottonseed, cottonseed-guayule resin, and soybean plywood panels that were manufactured. The cottonseed and cottonseed-guayule resin adhesives shows great promise as formaldehyde-free bio-based hardwood-plywood adhesives for interior applications. This research is ongoing.

Durability of 33-year-old Preservative Treated Test Structures in Mississippi

Brianna Duquette and Beth Stokes
Mississippi State University

ABSTRACT

Boron, a diffusible preservative treatment, has shown to be beneficial in biodegradation protection for wood products. In 1989, test house structures were built in Mississippi to research boron as a preservative. These structures were used to investigate the effectiveness of boron-containing treatments with exposure to natural weathering. These same houses are still standing and have not been disturbed for over 20 years. The objective of this study is to determine the effectiveness of boron treated houses over more than 20 years and compare the data from the previous research on these structures. This study will provide wood products industry professionals with long-term exposure data to improve the treatment of wood products. Practically, this research will aid the wood products industry in helping understand how well boron works as a long-term treatment against weathering, insects, and other biodegrading factors that affect wood properties.

How Industry-University Partnership Drives Innovation

Tâmara França
Mississippi State University

ABSTRACT

The wood industry and programs are facing challenges with maintaining and attracting adequate enrollment. At the same time, demand from industry for new hires has never been higher. The goal of this work is to show the efforts among eleven Wood Innovation and Sustainability Degrees across the country to enhanced exposure and awareness of wood products and wood industry. This work will present issues related to long-term, consistent challenges with maintaining adequate enrollment and demand from industry for new hires. In addition, this work will present marketing strategies and how stakeholders can contribute to build awareness of wood-based degree programs and the careers they make possible.

Automated Means to Wood Failure Prediction

Ramon Ferreira Oliveira, Dercilio Junior Verly Lopes, Edward D. Entsminger
Mississippi State University

ABSTRACT

The current method for estimating wood failure using the American Society for Testing Material ASTM D5266-13(2020) standard is highly subjective, requiring visual evaluation and mental estimation, and having made only minor advancements over the years. Additionally, various techniques have been proposed with the goal of improving the current protocol. However, none of them have been accepted as an accurate method by ASTM. Convolutional neural networks (CNN) have been demonstrated as a robust and trustworthy method for classifying, detecting, and segmenting objects in images in many different fields. To the best of our knowledge, there is no study to estimate wood failure using CNN. The overarching goal of this research is to use artificial intelligence/machine learning (AI/ML) to estimate wood failure in bonded three-ply hardwood plywood from mechanical shear strength specimens. The CNN approach needs to be accurately trained and validated with different parameters, namely wood and adhesives types, to be able to correctly generalize and predict truly unseen data. In preliminary experiments, we created a CNN based on the SegNet network. We trained and validated our approach with custom manufactured plywood. Shear specimens were prepared and tested. Pictures of 99 shear bonded areas were taken. These pictures were processed to create input masks from the failed areas. Eighty (80) pictures and input masks were used for training, and nineteen (19) for validation. The CNNs' prediction was tested on the validation set using four metrics and achieved accuracy = 0.99, F1-Score = 0.99, Matthew's Correlation Coefficient (MCC) = 0.98, and Jaccard Index (J) = 0.98. The next steps of this research include increasing the dataset and comparing the CNN's prediction with external evaluators' results. The major expected outcome of this research is that AI/ML will provide support to the wood composites industry, with a tool that estimates real wood failure with fast and highly accurate results, and with limited subjectivity.