THE UNIVERSITY OF MAINE 1865

SCHOOL OF FOREST RESOURCES

Reviewing Technologies and Processes for Eastern Hemlock

UMaine exploring technology for defect detection and trial processes for expanding Eastern hemlock utilization.

Highlights

This research was a continuation of a prior inventory and processing study on Eastern hemlock (*Tsuga canadensis*). During a previous industry listening session, it was determined that the operating sawmills have strong markets for products. However, these markets are limited to undried (green) timbers and rough sawn products.

Currently, no hemlock sawmills in Maine dry hemlock due to inherent challenges with hemlock of high rates of ring shake and both high and variable moisture content.

In this study, trials were conducted to explore the feasibility of acoustic ring shake and rot detection in logs, veneer peeling of hemlock logs, and kiln drying sawn hemlock to potentially expand marketable products and increase utilization of our resource in Maine.

From this study, it was determined there was an initial feasibility in both veneer peeling Eastern hemlock logs for use in plywood products and in kiln drying hemlock via a dehumidification dry kiln process.

A full review of processing optimization, material performance and techno-economic analysis would be required to fully evaluate either technology. However, this work has demonstrated an initial technical feasibility of both processes to warrant a deeper analysis.

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BACKGROUND

Expanding on a prior inventory and processing study on Eastern hemlock (*Tsuga canadensis*), this work explores the challenges of utilizing hemlock beyond pulp and green sawn products. Currently, all hemlock sawmills in Maine produce rough sawn green lumber. As a material, Eastern hemlock is susceptible to bacterial infection. The side effects of this infection is increased and variable wood moisture content and a higher likelihood of ring shake, a lengthwise separation of wood between and parallel to the growth rings. This defect reduces grade and yield in sawn lumber (especially thinner lumber) and is amplified by stresses imparted in the wood during kiln drying. The elevated green moisture content also impacts transportation, as the cost to transport a unit volume of wood is increased because of the added water weight.

In this study, three feasibility studies were conducted: 1) field detection of ring shake in logs, 2) veneer peeling of logs for potential use as core material in plywood, and 3) kiln drying processes. Any areas showing feasibility to continue into a greater depth of analysis could lead to either improving pre-screening to increase processing yields or establishing new marketable products and segments for hemlock to spur increased hemlock utilization in Maine.

ACOUSTIC EVALUATION

An acoustic non-destructive evaluation (NDE) of hemlock logs and sawn lumber was conducted at Parker Lumber (Bradford, ME). Bucked logs and sawn lumber were examined with a Fibre-gen Hitman HM220, an acoustical analyzer designed to non-destructively evaluate log stiffness in the field using time-of-flight acoustics. In this study, the HM220 was used to collect acoustic speed and wave spectral data to determine if the acoustical patterns can disseminate defects in the log. For each evaluated log, length, end diameters and defects were recorded; for sawn lumber, nominal dimensions and actual length were recorded. Figure 1 outlines the acoustical wave velocity data for the tested timbers and logs (categorized by observed log defects). Statistical analysis of the log testing data indicated no discernable difference between logs based on noted defects and quality. Sawn timbers showed a notable increase in wave velocity compared with log level data. This is likely due to the removal of defects during the milling process. However, it was found that this technology (in current form) is unable to delineate defect types in hemlock.

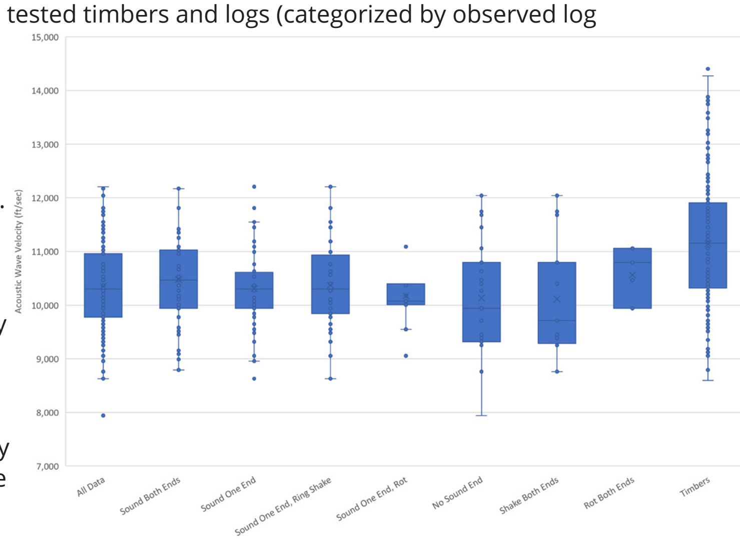

Figure 1: Acoustic Wave Velocities in Hemlock Logs and Sawn Timbers by Observed Defect Type

FUNDING AND SUPPORT

This effort was funded by USDA Agricultural Research Service project # 0204-41510-001-68S, focused on forest products research at the University of Maine.

Special thanks to our project's supporters, including:

- Columbia Forest Products *(Presque Isle, Maine)*
- Northeastern Lumber Manufacturers Association *(Cumberland Center, Maine)*
- Nyle Systems, Inc. *(Brewer, Maine)*
- Parker Lumber *(Bradford, Maine)*
- Stratton Lumber *(Eustis, Maine)*
- Techwood, LLC *(Lincoln, Maine)*
- Treeline, Inc. *(Chester, Maine)*

ABOUT UMAINE

The University of Maine, founded in Orono in 1865, is the state's premier public university. It is among the most comprehensive higher education institutions in the Northeast and attracts students from across the U.S. and 65 countries. UMaine students directly participate in groundbreaking research working with world-class scholars. The University of Maine offers doctoral degrees in 35 fields, representing the humanities, sciences, engineering and education; master's degrees in nearly 70 disciplines; 90 undergraduate majors and academic programs; and one of the oldest and most prestigious honors programs in the U.S.

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ABOUT THE SCHOOL OF FOREST RESOURCES

The Mission of the School of Forest Resources is to provide excellence in education, research, and public service that promotes the understanding, efficient use, and sustainable management of forest resources for the well-being of the people of Maine, the United States, and the World.

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HEMLOCK VENEER PEELING

High grade hemlock sawlogs harvested from the Penobscot Experimental Forest were processed with spruce and balsam fir logs for a separate university project at the Columbia Forest Products (CFP) veneer mill (Presque Isle, Maine). The CFP facility is a rotary peeling operation optimized for hardwood processing. Results from the plant trial indicated an initial feasibility of hemlock veneer peeling, and warrants a deeper investigation to optimize operation parameters, yield and grade evaluation and techno-economic analysis.

KILN DRYING SAWN HEMLOCK LUMBER

In this project, two separate drying trials were conducted using different drying technologies for feasibility.

Continuous Kiln Drying

Through review of the literature and conversations with several kiln manufactures, it was determined that hemlock has not been evaluated using a continuous kiln process. To determine feasibility, a unit of Millrun (ungraded) 2″x4″x8′ nominal hemlock was procured from Parker Lumber (Bradford, ME) and dried through a counter-flow continuous dry kiln at Stratton Lumber (Eustis, ME). Grading was conducted by Northeast Lumber Manufacturer's Association (NeLMA) at the Stratton site. The green unit was then processed through the kiln with Stratton's "heavy-fir" dimensional lumber, the highest moisture content green products which Stratton processes with the longest kiln time. After completing one drying cycle with the heavy fir, the hemlock unit was determined to be kiln dried to lumber specifications. The unit was processed through Stratton's planing mill and re-graded by NeLMA by the same grading expert. Figure 2 outlines the grading results of both the green and kiln dried lumber. It was found that while 82% of the mill run lumber graded out as #2 or higher in the green state, only 48% of the planed KD lumber met the same specification, resulting in a 34% downgrade due to drying defects. This was mostly contributed to an increase in shake defect propagation, an indicator of excessive drying stresses promoting delamination between the growth rings in the lumber. As a result, it was established that continuous drying (under the tested softwood operating conditions) was too aggressive in moisture removal for use in Eastern hemlock. This may be mitigated through refinements in temperature parameters and dwell time but would also impact drying costs and throughput.

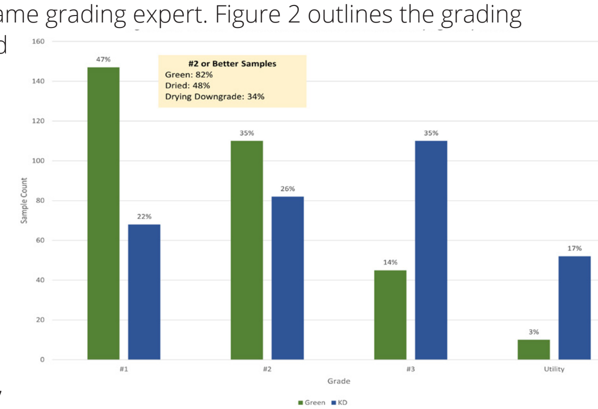

Figure 2: Continuous Kiln Dried Hemlock Grading Data

Dehumidification Drying

Due to the continuous kiln study findings, alternate drying technologies were explored, and dehumidification drying was identified as a potentially lower stress drying process for use with hemlock. 1,000 board feet of Millrun 1 1/8″ x 7″ x 12′ rough sawn hemlock was procured from Treeline, Inc. (Chester, Maine), and processed at Nyle Systems, LLC (Brewer, Maine) using the dehumidification process (Figure 3). Initial visual inspection shows a significantly decreased rate of shake defect propagation compared with the continuous process, and warrants a deeper investigation into downgrading, drying defect rates, cycle optimization, material characterization and techno-economics of processing at commercial scale to determine market viability.

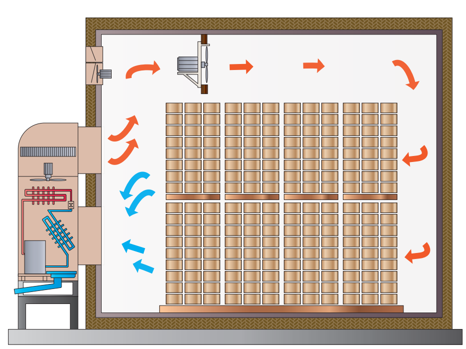

Figure 3: Dehumidification Dry Kiln Process

SPIG-011-02-21258