RESEARCH in Progress

Coalition for Advanced Wood Structures
a university, industry, government partnership

Statistical Investigation of Modulus of Elasticity and Modulus of Rupture Distributions in Mill Run Southern Pine Lumber

The Southeastern region of the United States produces the nation's largest volume of structural lumber. The several tree species that make up the Southern Pine lumber species group grow on hundreds of millions of acres across approximately 10 states. Annually, the value of lumber production from this resource is in the billions of dollars.

To maintain its competitive position, structural lumber properties must accurately reflect the strength and stiffness of the resource. In this manner, consumers receive a reliable and safe product with high economic and engineering value. Of key interest is the nature of lumber properties among the weaker specimens, which comprise the lower tail of the statistical strength distribution. As lumber comes from both younger plantation thinnings and older mature saw logs, investigating mixed populations is of interest.

The current best practice is to base strength design values on the nonparametric fifth percentile so that the design strength of lumber is independent of its statistical distribution. If strength distributions could be more accurately characterized, estimated lower tail strength values might increase, and higher economic value could be assigned to lumber while maintaining safety and conservatism.

Background

The wood reliability engineering community commonly models modulus of elasticity (MOE) as a normal distribution and strength as a normal, lognormal, or two-parameter Weibull distribution; or it sets these aside and uses a nonparametric fifth percentile. Preliminary research has shown that lumber populations may be composed of statistically mixed distributions. This is particularly true for mill run populations. Mill run populations are essentially all the lumber mills produce before the lumber gets meted out into various assigned grades. If the lower tail of strength populations (i.e., the weaker pieces) can be better modeled statistically, then it may be possible to improve reliability models, which in turn will lead to greater engineering efficiency and associated forest stewardship and conservation. Small changes in value, applied to tens of billions of board feet, equate to billions of dollars in economic activity spread across nearly 200 million acres of timberland.

Softwood lumber used in engineered glulam construction. With improved understanding of strength distributions, additional volumes of raw material will be available for these and other high-value markets.

U.S. Department of Agriculture • Forest Service
Forest Products Laboratory
www.fpl.fs.fed.us

USDA FOREST SERVICE

MISSISSIPPI STATE UNIVERSITY

Objectives

The primary objective of this study is to investigate and statistically analyze the stiffness and strength distributions of mill run Southern Pine lumber in an effort to generate an improved means of assessing left tail percentiles. The secondary objective is to investigate the use of a wide range of nondestructive evaluation technologies, including slope of grain detection via permittivity, as a means of improving the predictability of stiffness and strength of structural pine lumber as well as improving the automation of these properties.

Approach

For this project we will (1) procure 1,400 kiln-dried, rough, mill run southern yellow pine (*Pinus* spp.) lumber specimens from four sawmills, (2) transport the specimens to Mississippi State University, (3) dress the lumber to 1.5- by 3.5-in. dimensions, (4) perform several nondestructive tests on each specimen, including automated assessment of slope of grain via permittivity, (5) destructively test each specimen to establish its stiffness and strength, and (6) perform statistical analyses of the resulting data with particular interest in describing the lower tail from mixed populations.

Expected Outcomes

This project is expected to establish novel information that can be used in developing improved parametric assessments of the left tail percentiles of lumber strength distributions. Thus, it should be possible to better estimate appropriate and conservative structural design values for pine lumber, which will lead to more jobs and higher economic value and returns for lumber manufacturers and timberland owners.

Timeline

The experimental phase of the project will run from July 2017 through August 2018. Statistical analyses will follow through June 2019. Final reporting and dissemination will conclude by June 2020.

Cooperators

Mississippi State University

USDA Forest Service, Forest Products Laboratory

Contact Information

Robert J. Ross
USDA Forest Service, Forest Products Laboratory
Madison, Wisconsin
(608) 231-9221; rjross@fs.fed.us

Rubin Shmulsky
Mississippi State University
Starksville, Mississippi
(662) 325-2119; rshmulsky@cfr.msstate.edu