CHARACTERIZING WOOD PROPERTIES OF SMALL DIAMETER NORTHWEST TREES

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Forest lands of the Rocky Mountain region of the U.S. have many timber stands consisting of overgrown, densely stocked trees that create a fire hazard and are prone to disease. These stands need to be thinned, but the cost of harvesting often exceeds the value of the timber produced. However, because of the dense stocking and the resulting slow growth these trees may produce lumber with desirable mechanical properties. One method for sawmills to more fully utilize the potential grade yield and realize greater economic return from such lumber may be to produce Machine-Stress-Rated (MSR) lumber instead of visually graded dimension lumber.

MSR lumber is physically tested by a machine to more accurately estimate its mechanical properties, including stiffness and bending strength. MSR lumber is distinguished from visually graded lumber in that each piece is nondestructively tested and marked to indicate its strength and stiffness. MSR lumber benefits the user by assuring that the strength value of any board is more precisely defined. This is of particular importance in engineered structural components such as laminated beams, trusses, and fabricated joists where MSR lumber is typically used. High strength MSR lumber can command a higher price in the lumber market.

The purpose of this study was to determine the mechanical properties, and corresponding economic value, of dimension lumber produced from selected over-stocked forest stands of small-diameter lodgepole pine (northern Idaho), grand fir (northern Idaho), white fir (Colorado) and ponderosa pine (northern Idaho, central Idaho, western Colorado, and northern Arizona). After harvest, logs were processed into 2x4 (3.81 x 8.89 cm) dimension lumber by cooperating local sawmills, kiln-dried, and surfaced on four sides. The lumber was visually graded and tested for modulus of elasticity and modulus of rupture, and each piece sorted into two types of grade categories: 1) visual Structural Light Framing and 2) Machine Stress-Rated.

The dynamic modulus of elasticity (MOE) for each 2x4 was nondestructively determined using a Metriguard Model 340 Transverse Vibration E-Computer. The E-Computer determines MOE based on resonant vibration frequency and density. Each 2x4 was simply supported flatwise as a beam spanning the entire length of the board, and the specimen was then set into vibration by gently tapping it near the center of the span. A load cell measured the frequency of vibration and board weight, and the E-Computer calculated MOE for each piece. In an industrial setting, each board would be fed into a continuous lumber tester to assess the dynamic MOE, and an identifying color would be automatically sprayed onto each piece to assist the lumber grader in evaluating the final grade.

An Instron Model 1137 Universal Testing Machine was used to perform the static mechanical strength and stiffness tests; no tension tests were included in this study. Data was collected via a National Instruments model PC-LPM-16 data acquisition board and Measure software. The testing was performed per ASTM Standard D 198 with the 2x4's loaded on edge. Third point loading was used to create constant moment in the center third of the span. Span length was 187 cm (73.5 inches) to achieve a span-to-depth ratio of 21:1. Pieces were tested such that maximum strength-reducing characteristics were randomly located. Each piece was loaded at a 2-inch per minute rate of deflection and loading proceeded until ultimate failure. The time to failure averaged approximately one minute. Deflection was measured using a linear voltage differential transducer (LVDT), and force was measured with the load cell on the Instron machine.

Immediately after breaking, a small sample was removed from each 2x4 near the point of failure to determine moisture content and specific gravity. The moisture content of each sample was measured using the oven-dry method specified by ASTM Standard D 4442. Specific gravity, based on oven dry weight and volume at time of test was determined according to ASTM Standard D 2395.

The static MOE, MOR, and visual grade data for each piece was used to sort the lumber into MSR categories. WWPA rules allow sorting into any design bending strength (Fb) and modulus of elasticity (E) combination. However, there are a limited number of categories that are commonly marketed in the Western United States, and for the species considered in this study they include 2400Fb - 2.0E, 2100Fb - 1.8E, 1800Fb - 1.6E, 1650Fb 1.5E, and 1450Fb - 1.3E (14). For this study only 2400Fb - 2.0E, 2100Fb - 1.8E, 1650Fb - 1.5E, and 1200Fb - 1.2E categories were considered. The 1450Fb - 1.3E category was not considered because there is less of this grade produced. The 1200 Fb - 1.2E category, though limited in the market, was considered as an option for ponderosa pine. The MSR categories were compiled according to American Lumber Standard (ALS) Committee rules.

The results of this study demonstrate the potential for MSR grading of lumber sawn from small-diameter trees in the several Rocky Mountain locations; however, individual mills must assess their resource to determine the potential grade output and conduct a market study to determine if the cost of installing MSR equipment can be justified. For example, the lodgepole pine and grand fir from northern Idaho, as well as the ponderosa pine from western Colorado, exhibited good mechanical properties that would yield higher value lumber if MSR sorting were possible. Value increases up to $30 per Mbf (thousand board feet) were determined to be possible for some species, given current market values. Consequently, the properties of lodgepole pine and grand fir lumber from northern Idaho should justify an investment in MSR equipment. On the other hand, the Idaho ponderosa pine lumber and the Colorado white fir lumber gave poor yields of MSR lumber, and were judged

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not to be good candidates for production of MSR lumber. The yield of MSR lumber from ponderosa pine stands in Colorado and Arizona was marginal; local markets for the particular grades that could be produced from those resources would need to be carefully determined before investing in MSR equipment.

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