GENERAL PHYSICAL CHARACTERISTICS OF DAHURIAN LARCH (LARIX DAHURICA) FROM THE RUSSIAN FAR EAST

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ABSTRACT

There is growing interest in importing wood for structural lumber and, thus, interest in developing standardized methods of sampling and testing wood from foreign sources that will be acceptable and reliable in the American Standard grade-marking system. Toward that goal, a sample of dahurian larch (Larix dahurica, or Larix gmelinii in some literature) was obtained, amounting to 696 samples of 2 by 4's that were 3.7 m long. This paper describes the species and the sample in some detail, including general physical characteristics of the wood. The lumber was slow grown with small knots and fairly frequent shake. It is similar to western larch (L. occidentalis) in growth rate, percent latewood, and specific gravity.

By the fall of 1990, the forest products manufacturing industry in Oregon and the Pacific Northwest, particularly the lumber, plywood, and pulp segments, were intensely concerned with raw material supply. They searched for outside sources of raw material due to declining domestic log supply, and there remains considerable interest in using structural lumber produced from foreign sources like Russia, Chile, and New Zealand.

The largest potential source of softwood logs for structural lumber in the world is Russia. It is estimated that growing stock east of the Ural Mountains is about 40 billion m³ and one third of this is larch (4). Of this larch, about 56 percent is dahurian larch (Larix dahurica Elw. et Henly), growing in an area equivalent to six times the state of Oregon. Dahurian larch of commercial size and quality grows east of about 110° east longitude, which mostly encompasses the Russian Far East.

However, allowable properties of foreign structural lumber are not incorporated in U.S. design manuals (13), and relatively little work has been done on sampling and testing procedures that would yield allowable properties consistent with those used for domestic woods. The purpose of our study has been to adapt and test procedures developed under the aegis of the American Lumber Standard Committee for determining allowable properties of lumber from a foreign source.

We selected dahurian larch for this study because of the immense volume that exists, with the expectation that it is one of the likely candidates for importation for structural lumber. This paper describes the sample we obtained and the general character of the wood. Subsequent papers will provide findings about mechanical and visual lumber stress grades (6,8,9).

LITERATURE REVIEW

A treatise on larch wood in Russia by Bokshchanin (3) gives a great deal of information about larch properties and uses. It treats larches collectively, and places no special emphasis on dahurian larch. It describes larch as a relatively heavy wood, with “...weight of larch wood products...comparable to those made of hardwoods.” Heartwood is yellowish red; sapwood slightly pinkish. Heartwood volume is about 70 to 75 percent of total volume and decreases from tree base to top.

Tangential and volumetric shrinkage of dahurian larch are reported greater than all other (Russian) species, and tangential shrinkage is reported to be much different than radial shrinkage (Table 1). It is reported to be prone to shake when dried (except in quarter-sawn boards), and this is credited to the radial versus tangential shrinkage difference. Bokshchanin also says that high resin content is a major impediment to use, and notes that 60 percent of resin pockets are within 2 cm of the log surface. He also discusses water soluble gum (undoubtedly the same or similar to arabogalactan five carbon sugars reported in western larch (2,14)), indicating it is mostly in heartwood, and is 9 to 17 percent (we presume by weight).

Bokshchanin states, “Compared to other species, larch wood is quite decay resistant.” But Morrell and Freitag (11) evaluated dahurian larch heartwood and reported that it has little natural resistance to fungal attack when tested and rated by familiar U.S. procedures. They point out that this difference in perception about durability “...may reflect a dif-
TABLE 1. — Average clear wood properties of larch from world literature.

<table>
<thead>
<tr>
<th>Species</th>
<th>Specific gravity</th>
<th>MOR</th>
<th>MOE (×10³)</th>
<th>Compressive strength</th>
<th>Shear strength</th>
<th>Shrinkage</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Parallel</td>
<td>Perpendicular</td>
<td>Radial</td>
</tr>
<tr>
<td>L. dahurica</td>
<td>0.65</td>
<td>15,100</td>
<td>1.8</td>
<td>8,200</td>
<td>--</td>
<td>970</td>
</tr>
<tr>
<td>L. dahurica</td>
<td>0.64</td>
<td>16,100</td>
<td>2.0</td>
<td>8,200</td>
<td>925</td>
<td>1,200</td>
</tr>
<tr>
<td>L. dahurica</td>
<td>0.70</td>
<td>15,700</td>
<td>1.8</td>
<td>7,500</td>
<td>925</td>
<td>1,300</td>
</tr>
<tr>
<td>L. dahurica</td>
<td>0.65</td>
<td>17,000</td>
<td>--</td>
<td>9,400</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>L. occidentalis</td>
<td>0.52*</td>
<td>13,000</td>
<td>1.9</td>
<td>7,620</td>
<td>930</td>
<td>1,360</td>
</tr>
</tbody>
</table>

*Measured with volume at 12 percent moisture content.

TABLE 2. — Distribution of lumber sample by location and grade.

<table>
<thead>
<tr>
<th>Grade</th>
<th>Location</th>
<th>Select Structural</th>
<th>No. 1</th>
<th>No. 2</th>
<th>No. 3</th>
<th>Lower than No. 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>158</td>
<td>72</td>
<td>58</td>
<td>49</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>144</td>
<td>64</td>
<td>86</td>
<td>47</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>302</td>
<td>136</td>
<td>144</td>
<td>96</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. — Map of far east Russia showing two sample sites.

Fer view of durability in the two countries.” Morrell and Schneider (12) experimented with treatability using waterborne preservatives, and suggest that “...adequate treatment of dahurian larch would require incising and long vacuum-pressure cycles similar to those used for Douglas-fir, western larch, and other refractory wood species.”

Bokschuanin recommends against high-temperature drying (said to be temperatures near 100°C) unless some darkening and strength loss can be tolerated, but a drying schedule for lower temperatures is provided.

There is only scattered information, from several different sources, regarding physical and mechanical properties of dahurian larch, and it focuses on clear wood mechanical properties. Table 1 provides a summary of that information, with comparative data on U.S. western larch (Larix occidentalis) from the Wood Handbook (7). The clear wood values reported in Table 1 are for “dry” wood, probably 12 to 15 percent moisture content (MC), and were obtained by a variety of sampling and test methods. Therefore, there is little one can conclude, except that larch from Siberia is probably roughly similar in clear wood properties to larch from the western United States.

Experimental Design

We expected to examine relations between mechanical properties using regression. To seek strong regressions if they exist in the population sampled, it was important to stratify the sample and work toward a uniform distribution of samples in all strata. We used visual grades as strata to assure a range of quality because we anticipated it would be easier to select pieces visually in the rough, green condition than to move equipment there and make controlled tests. We obtained similar samples at two locations to test our assumption that there were no location differences in interproperty relationships. Our sample locations were 55 km apart, between Khabarovsk and Vladivostok (Fig. 1).

Our collaborator in the sampling phase, who was from the Far East Forest Research Institute in Khabarovsk, collected the sample and assured us it was dahurian larch. The two sites were both described as being excessively wet, with essentially pure larch stands. On one site the trees were 160 to 200 years old, growing stock 80 to 90 m³ per ha, with an average height of 18 m with a diameter at breast height (DBH) of 26 to 28 cm. The other site had trees 160 to 180 years old, growing stock 90 to 120 m³ per ha, average height 17 m, with a DBH of 29 to 30 cm.

At the Far East Forest Research Institute, the logs were sawed to 50 by 100 by 3,670 mm in a gangsaw, graded, and dried in a hot-air, oil-fired dry kiln at 75°C for 3 days. Many pieces contained the pith, or were close to it, because of the small log size and because the sawing method favored it. The U.S. grades were expected to be unfamiliar in Russia, so a U.S. lumber inspector was employed to travel to the site and grade the lumber in the rough green condition. This was done in August 1992; the lumber was shipped out of Vladivostok in the autumn, and it arrived at Vancouver, Washington, in November 1992.

Sample

We specified 81 pieces of lumber in each of the four visual grades from No. 3 through Select Structural for each location. The grading was based on strength-affecting characteristics only (knots and slope of grain) as described by National Grading Rules and given in paragraph 124 of the WCLIB Grading Rule Book (15). Dahurian larch is a relatively small-knotted species, and it is difficult to grade rough lumber. For those two reasons, we did not achieve the uniform distribution across grades that we sought, and there were more pieces in the higher grades, but our sampling procedure did tend to spread the sample. The distribution of samples by location and grade is given in Table 2.

When received, the lumber was shipped to Frank Lumber Company in Mill City, Oregon, where it was surfaced to 38 by 89 mm and passed through a
CLT-1 grading machine. Specimens were ranked by low-point modulus of elasticity from the CLT-1, and serial triplets were randomly assigned to three groups. Two of those groups were shipped to the Forest Research Laboratory in Corvallis, Oregon, to be tested in full-scale bending and tension; the third was shipped to the USDA Forest Products Laboratory in Madison, Wisconsin, to be tested in full-scale compression parallel to grain. The observations reported in this paper were made on the specimens shipped to Corvallis only.

Figure 2. — Typical knots in dahurian larch lumber.

CLT-1 grading machine. Specimens were ranked by low-point modulus of elasticity from the CLT-1, and serial triplets were randomly assigned to three groups. Two of those groups were shipped to the Forest Research Laboratory in Corvallis, Oregon, to be tested in full-scale bending and tension; the third was shipped to the USDA Forest Products Laboratory in Madison, Wisconsin, to be tested in full-scale compression parallel to grain. The observations reported in this paper were made on the specimens shipped to Corvallis only.

Moisture content

When received, the lumber was sampled for MC with a resistance moisture meter set for western larch. This showed that the MC of the lot was well above the target 15 percent MC, and typical pieces were well above fiber saturation point. Therefore, the lumber was stickered, placed in a kiln, and dried to the vicinity of 19 percent.

Following kiln-drying, the stickered lumber was placed in a room conditioned to 15 percent equilibrium MC for 3 to 4 months. At that time it had reached equi-

librium, as indicated by the constant weight of a sample board.

Physical property measurements

A single cross-sectional slice about 25 mm along the grain was taken from each piece of lumber in one of the two groups shipped to Corvallis. On that slice, a representative radial line was established, and growth rate and percent latewood along the line were estimated by naked eye using a millimeter scale. Specific gravity based on oven-dry weight and volume at 15 percent MC was determined on all pieces except those that fell below grade No. 3, according to methods described in ASTM D 2395 (1).

General observations

Because of the fairly wet condition of the lumber as received, there was considerable buildup of exudate on the rollers of the planer and grading machine. The exudate was readily removed with hot water, suggesting it was the “gum” or sugar reported in the Russian literature, and similar to the sugar known to exist in western larch. Pitch pockets were occasionally observed, but we did not see them in an abundance that would be “a major impediment to use,” as suggested by Bokschin.

The lumber was relatively slow grown, either clear or nearly so, or with small, tight knots. Figure 2 shows a typical knot. Figure 3 shows end-grain on six pieces, giving an impression of the variation that existed in growth rate and percent latewood. Moving clockwise from the piece in the upper lefthand corner in Figure 3, the specific gravities of the pieces are 0.79, 0.60, 0.78, 0.60, 0.58, and 0.56. Thus, in the array of lumber in the entire sample, these pieces are all above average in specific gravity. The two upper pieces on the left show examples of the ring shake that was fairly abundant. The lower righthand piece shows a band of compression wood; compression wood was rare in this lumber.

There was no significant difference (95% confidence) between measured physical properties for wood from the two sites. Table 3 provides pooled statistics compared with those of western larch. With 99 percent confidence, we were unable to show a difference for percent latewood for dahurian larch, compared to that reported for western larch. Specific gravity is significantly higher,
Table 3. — Statistics of samples for selected properties.

<table>
<thead>
<tr>
<th>Property</th>
<th>Average</th>
<th>Coefficient of variation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dahurian larch</td>
<td>Western larchb</td>
</tr>
<tr>
<td>Moisture content at test (%)</td>
<td>15.7</td>
<td>-</td>
</tr>
<tr>
<td>Specific gravity</td>
<td>0.53</td>
<td>0.51</td>
</tr>
<tr>
<td>Growth rate (rings per in.)</td>
<td>29</td>
<td>32</td>
</tr>
<tr>
<td>Percent latewood</td>
<td>39</td>
<td>37</td>
</tr>
</tbody>
</table>

b Growth rate and percent latewood taken from (10), table 1. Specific gravity taken from (7), table 4.2, adjusted to 15 percent moisture content.

and growth rate significantly lower than for western larch. However, our tests were unusually sensitive because of the large sample size. In real terms, the sample averages, and those reported for western larch are quite similar.

Summary

A sample of about 700 pieces of dahurian larch from the Russian Far East was acquired for evaluation of mechanical properties. Physical properties were measured before destructive testing. The physical characteristics of dahurian larch were similar to those of western larch found in the United States. Dahurian larch is a small-knotted species, with fairly abundant shake. When wet, considerable water-soluble exudate is present, especially if passed through compression rolls. The average specific gravity of this sample is 0.53, based on volume at 15 percent MC. Growth rate is 29 rings per inch (2.4 mm), and it has 39 percent latewood.

Literature Cited