Mechanical Properties of Western Juniper

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Introduction

In October, 1994, thirty-eight (38) western juniper (*Juniperus occidentalis*) trees were harvested on eight sites throughout the range of the species (see Figure 1). Specifically, two sites in northern California, two sites near Klamath Falls, OR, two near Sisters, OR and two in east-central Oregon near Burns. The specimen trees chosen were judged to be typical of area trees in regards to stem form, height, diameter, and crown morphology. Selected trees were free of obvious defects such as twin tops, decay, fire or mechanical-damage scars, dead sections of crown or evidence of insect attack. After felling and limbing, the stems were measured for ground-to-tip length and bucked into 9-foot-long sections, to a 6-inch top. Trees ranged from approximately 10 to 20 inches diameter at breast height (4.5 feet), and 30 to 75-feet in height. Most trees yielded 3-4 9-foot sections. Each section was labeled, and end-coated with paraffin to prevent drying, and shipped to Missoula, Montana for testing.

Clear (straight-grained and free of knots and other defects) test specimens for static bending, shear, tension, compression (maximum crushing strength), surface hardness, nail withdrawal, wood density and shrinking and swelling behavior have been made from one tree from each of three of the eight locations. Tests are performed in accordance with the American Society for Testing and Materials (ASTM) Standard D-143, which specifies the methods to be used for evaluating the clear wood properties of all species in both the never-dried (green) and air-dried (12% moisture content) condition. Specifically, one site in California, south of Alturas , one site east of Klamath Falls and one site north of Burns have been investigated. Due to the probable variability of the wood properties of the species and the actual testing of such a small part of the total trees collected, no statistically-valid conclusions regarding differences between geographic locations or position in the tree, can be drawn at this time. The following results of a few of the planned tests of green material only allow for a preliminary assessment of the structural properties of western juniper, a "ballpark estimation" of what is to come.

Results

Table 1. Mean values and ranges of strength properties of western juniper and other similar species.

Property	w. juniper	e. redcedar	w. redcedar	incense-cedar	pond. pine
Specific Gravity[1]	0.40 (0.38-0.42)	0.44	0.31	0.35	0.38
Static Bending					
MOE[2]	700 (680-750)	650	940	840	1,000
MOR	6.9 (6.5-7.7)	7.0	5.2	6.2	5,100
Shear Parallel	1.4 (1.2-1.6)	1.0	.77	.83	.70
Max. Crush Strngth	4.6 (4.2-5.0)	3.5	2.8	3.1	2.4

Specific Gravity

Specific gravity is a unitless measure of the relative densities of a substance and water. All materials with specific gravities less than that of water (1.0) will float. Specific gravity has strong correlations with several strength properties such as MOR, crushing and shear strength, and also affects the use of wood in non-structural situations such as surface wear, hardness and nail-holding capacity. The three trees studied had an average green specific gravity less than that of eastern redcedar, but greater than the other comparison species.

Static Bending-Modulus of Elasticity

Static bending tests evaluate the stiffness and breaking strength of a species and are conducted on 1"x1"x16" pieces supported at each end with a continuously-increasing load applied in the center. The deflection at the midpoint and the total load to break the piece are used to determine the stiffness or modulus of elasticity (MOE)) and breaking strength (modulus of rupture (MOR)). Results show that these western juniper trees to have never-dried MOE values roughly equivalent to those of eastern redcedar, and less

[1] Specific gravity based on weight ovendry and green volume

[2] values for MOE, MOR, shear and compression in psi x 10^3

than other similar species.

Static Bending-Modulus of Rupture

Modulus of Rupture in bending reflects the maximum load-carrying capacity of a member. Results show that the tested western juniper trees had higher green MOR's than other similar species.

Shear Parallel to the Grain

Shear strength, measured with stress applied parallel to the grain, is a strength property important in many applications such as bending strength. The results show the shear strength of green western juniper to be significantly greater than similar species.

Compression Parallel to the Grain-Maximum Crushing Strength

Maximum crushing strength is the maximum compression stress sustained by a sample. Results show western juniper to have higher average values than any of the group of similar species. Crushing strength is particularly important when wood is used in applications with high axial loadings (posts and columns supporting large loads).

Conclusions

Green, clear-wood strength properties for the three trees studied to date compare quite favorably with values for similar species. The one property that is lower than that of the other species is Modulus of Elasticity, a significant factor in the determination of the suitability of a species for many structural and some non-structural uses. Since wood is used at a moisture content between 6 and 15 percent, the green-wood strength values are valuable for comparative purposes only. When samples to be tested at 12 percent moisture content have completed drying, they will be tested and compared to the like values for the comparative species.

At this time it appears that structurally, western juniper appears to be a candidate for many, if not all, of the structural uses the similar species are put to, given the limitations of the relatively small stem size. These products would include millwork, plaquetery, structural and decorative veneers, toy parts, sash and frame components, lath, stakes, fence post and board stock.

The genus *Juniperus* is noted for its fine wood texture (small cell diameters), which accounts for its excellent machinability. Any product that requires this attribute is a candidate for trial, and will likely be unsuitable only because of some other property of the species.

The appearance of the sawn product is excellent, with the "tight grain" (narrow growth rings) very appealing to former users of old-growth pine and Douglas-fir. The reddish-brown heartwood is not as vibrant as eastern redcedar nor does it possess the same "cedar chest" odor. The heartwood does, however, have a distinctive "cedar" smell that lies somewhere between the pleasant aroma of eastern redcedar and the acrid odor of incense-cedar or baldcypress.

One problem of note at this point is the propagation of small, radially-aligned seasoning checks, which appear to act as crack initiation points and can cause the splitting of wide, flat-sawn boards, or panels edge-glued from narrow flat-sawn stock. End-coating of logs and lumber prior to drying will most likely help limit the occurrence of some of the checking, but further investigation into the source of this problem is needed.

The bark provides both a problem and a potential asset for the utilization of the species. Fibrous in nature, the bark is difficult to remove with a ring debarker, as it becomes entangled in the rotating head of this machine. A rosserhead debarker, consisting of a rotating cutterhead passing along the log, would most likely do a reasonably good job of debarking cylindrical and conical logs, but will have problems removing the bark from inside the many characteristic clefts and cavities. A chain flail debarker may be a solution, as it has met with relative success in debarking eastern redcedar. Hydraulic debarking may also provide a reasonable solution to this problem. It is also possible that a combination of hydraulic and mechanical debarkers may be practical.

The fibrous bark may also find uses in composite products requiring low-cost fiber, such as wood/bark-portland cement products. Previous work indicates that extractives found in the bark of many species retards or prevents the hardening and final curing of portland cement, and a neutralizing pretreatment of the bark may have to be employed.

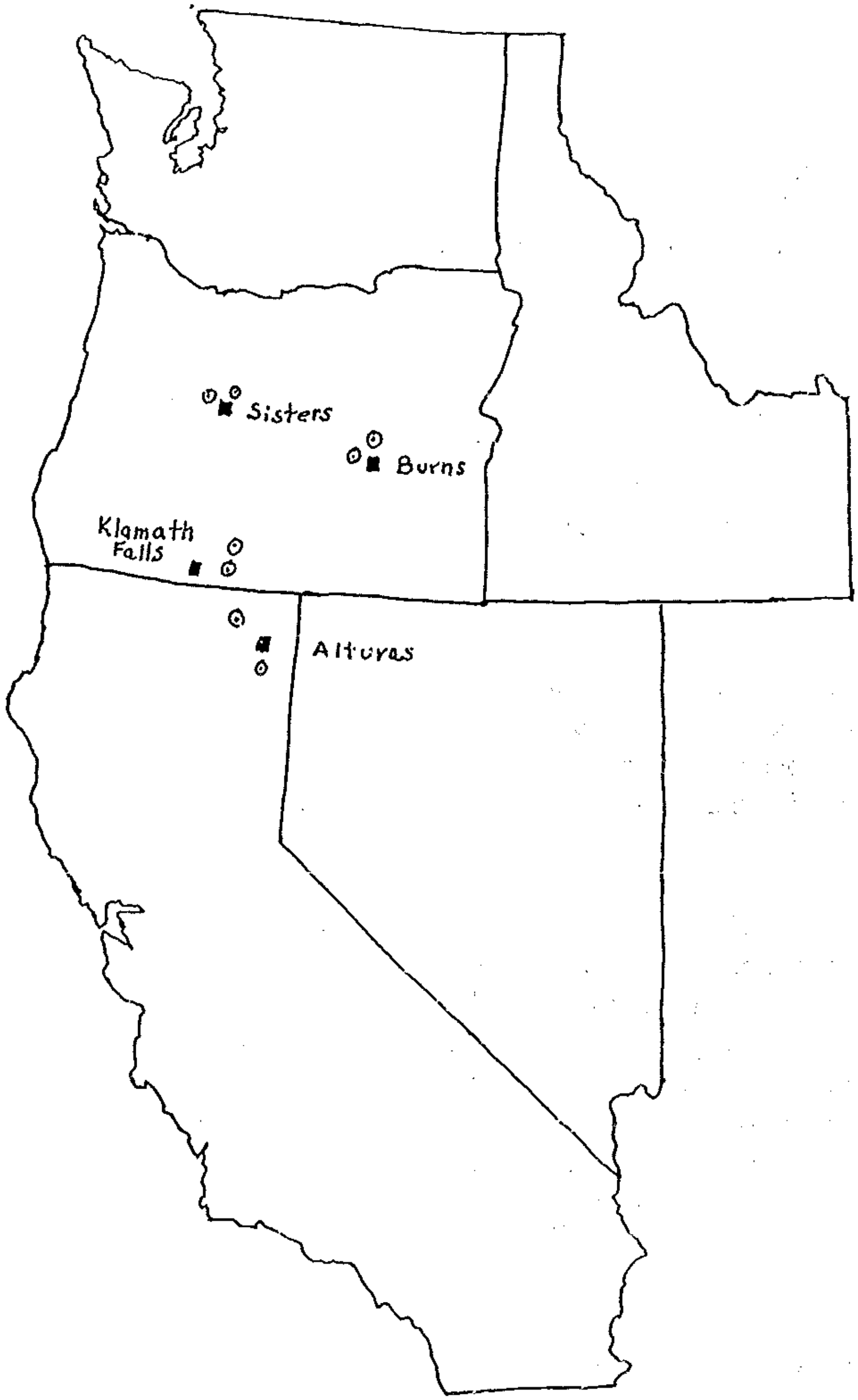

Figure 1. Location of sample sites.