Selected Characteristics of Colorado Woods

Wood species	Paint-holding characteristic		Weathering	Heartwood						
	Oil based paint	Latex paint	Resistance to cupping	Decay resistance	Ease of treating	Color of heartwood	Ease of machining	Resistance to splitting in nailing and screwing	Nail and screw holding ability	Ease of bonding
Aspen	2	3	3	1	3	Pale brown	3	4	2	4
Douglas-fir	1	3	3	2	1	Pale red	3	3	4	3
Engelmann Spruce	2	3	3	1	2	White	3	4	2	4
Limber Pine				1						
Lodgepole Pine				1	2	Pale yellow	3	3	2	3
Pinon Pine				1	4					
Ponderosa Pine	2	3	3	1	4	Cream	4	4	2	4
Plains Cottonwood	2	3	1	1	3	White	1	4	2	2
Subalpine Fir	2	4	3	1	1	Pale tan	2	4	2	4
White Fir	2	4	3	1	2	White	2	4	3	4

Excellent 4 Very Good 3 Good 2 Fair 1

COLORADO WOOD UTILIZATION AND MARKETING ASSISTANCE CENTER

The Colorado Wood Utilization and Marketing Assistance Center is a collaborative between Colorado State University, the Colorado State Forest Service, and the US Forest Service. Its mission is to contribute to the improvement and maintenance of healthy forests conditions in Colorado through extension and outreach in the areas of wood science, forest products and business assistance. It was designed to help communities and businesses utilize the wood products made available from fuel reduction and forest restoration thinning activities in Colorado.

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This publication was funded in part by a grant from CSU's College of Natural Resources and the Renewable Resource Extension Act

Physical and Mechanical Properties (continued)

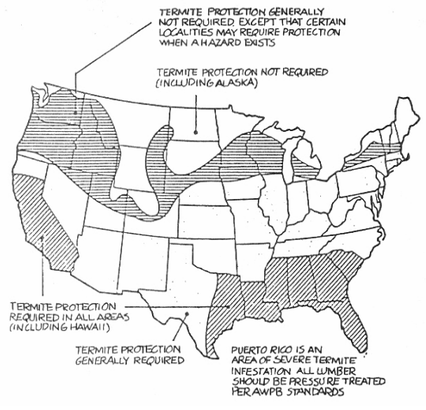
maximum crushing strength; compression perpendicular to grain is fiber stress at proportional limit; shear is maximum shearing strength; tension is maximum tensile strength; and side hardness is hardness measured when load is perpendicular to grain.

Most code requirements for wood interior finish materials are expressed in terms of flame spread index numbers. These values are determined in a standard fire test which evaluates the surface burning characteristics of a material. Different maximum flame spread indices are permitted depending upon building occupancy, location of the material in the building, and the presence of sprinklers.

Class	Flame Spread Range	Example Location
I or A	0-25	Enclosed vertical exits
II or B	26-75	Exit access corridors
III or C	76-200	Other rooms and areas

Working Properties: Lodgepole pine is easy to work with tools, easy to glue, average in paint-holding ability, and holds nails or screws moderately well.
Preservation: The heartwood is difficult to treat with preservatives, but the sapwood is permeable.
Toxicity: In general, working with lodgepole pine wood can cause dermatitis, allergic bronchial asthma, or rhinitis in some individuals.
Durability: It is not durable under conditions that favor decay and should be treated with a preservative. The wood can be susceptible to attack by dry wood termites, ambrosia (pinhole borer) beetles, longhorn beetles, and Buprestid beetles.

Additional Information



The Wood Handbook: Wood as an Engineering Material, FPL-GTR-113. USDA Forest Products Laboratory, Madison, WI.

National Design Specification for Wood Construction. American Forest and Paper Association, Washington, DC.

Western Lumber Grading Rules. Western Wood Products Association, Portland, OR.

Colorado Wood Utilization and Marketing Assistance Center

Product Use Guide

Lodgepole Pine

By David G. Bueche

"We may use wood with intelligence only if we understand wood."

—Frank Lloyd Wright
In the Cause of Architecture: Wood
The Architectural Record
May 1928

Wood is used in many forms throughout the world. However, few people fully understand the properties and peculiarities that must be considered for optimum application. This publication was developed as an aid for furthering the understanding of wood. It is a compilation of scientific and trade names, tree and wood characteristics, including: weight; physical and mechanical properties; drying, shrinkage, and working properties; durability, preservation, toxicity, and uses for wood species native to Colorado.

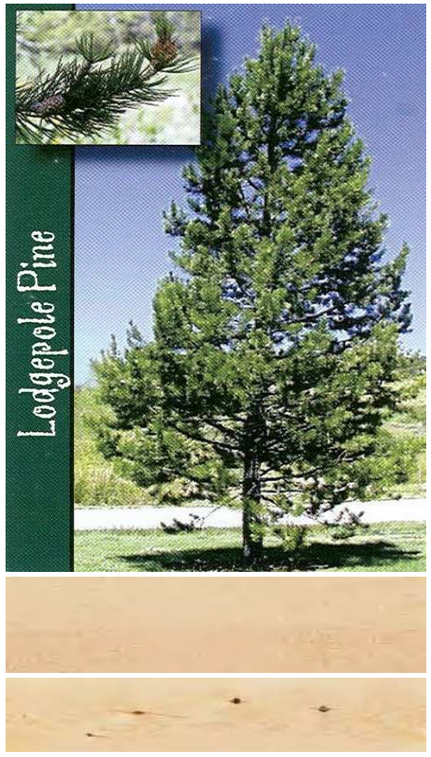
Inside Lodgepole Pine:

Colorado State University
Knowledge to Go Places

Colorado Woods

Lodgepole *Pine*

Pinus contorta



Description

The word *pinus* is the classical Latin name. The word *contorta* means contorted or twisted, alluding to the irregular crown of the typical, scrubby shore pine of the coast. Poles of this tree were used by Native Americans for litters, drag sleds, teepees, and lodges.

The Tree: Lodgepole pine trees vary in growth rate, depending upon location. Trees from Colorado reach heights of 80 ft with diameters of 1 ft.

Bark: Light brown, thin with many small scales.

Leaves: Evergreen needles are yellow to dark green; 1 to 3 inches long; sharply pointed, stiff stout, slightly flattened and often twisted; 2 needles in a bundle.

Fruit: Shiny, yellow-brown, egg-shaped, serotinous* cones; 3/4 to 2 inches long with raised, rounded cone scales and a tiny point. *Seeds released from cones by exposure to extreme heat.

Elevation: 6,000 to 11,000 feet.

Habitat: Mostly well-drained soils in high elevations, often in pure stands.

Relation to Fire: Ground fires kill many trees due to thin bark. New stands quickly establish when cones open and seeds are released.

General Wood Characteristics

Sapwood nearly white to pale yellow, narrow; *heartwood* light yellow to pale yellowish brown, often scarcely darker than the sapwood and not clearly distinct; *wood* with a distinct, non characteristic, resinous odor (especially when green), without characteristic taste, generally straight- but somewhat uneven-grained, medium to fine-textured, frequently prominently dimpled on the tangential surface (split), moderately light in weight, moderately soft, moderately weak in bending and endwise compression, and moderately low in shock resistance. *Growth rings* distinct, not as conspicuous as in many of the other hard pines, delineated by a band of darker late wood. Early-wood zone wide or narrow (outer rings of mature trees); transition from early to late wood more or less abrupt; late-wood zone narrow but distinct, not appreciably more resistant to tools than the early wood.

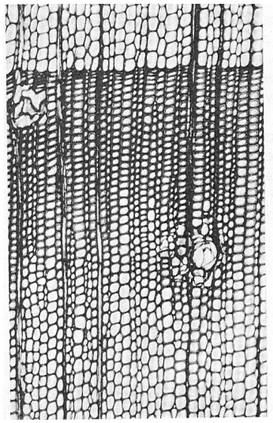
Uses

Historic—railroad ties, mine timbers, lumber, house logs, and rough construction. Current 8-ft studs, knotty pine paneling, shelving, cabinetry, millworks, interior finish, fence posts, framing, siding, finish, flooring, corral rails, transmission or telephone poles, house logs, veneer, plywood, pulpwood, and firewood. *Mine timbers; poles; posts; railroad ties; pulpwood;* suitable for *hardboard* and *particle board; lumber* for rough construction, frequently mixed with spruce; *planing mill products*, such as siding, knotty pine paneling, and flooring; veneer for decorative faces for prefinished plywood; locally for corral rails; orchard props; rustics furniture and shingles.

Lodgepole pine is used for lumber, mine timbers, railroad crossties, and poles. Less important uses include posts and fuel. Lodgepole pine is being used increasingly for framing, siding, millwork, flooring, and cabin logs.

Minute Anatomy

Tracheids up to 55 (avg 35-45) µm in diameter, those in the dimpled areas swirled as viewed in the tangential section; bordered pits in 1 row or occasionally paired on the radial walls; tangential pitting wanting in the last few rows of late-wood tracheids (sometimes appearing to be present owing to a twist in the tracheids); pits leading to ray parenchyma pinoid, variable in size and shape, 1-6 (generally 2-4) per cross field. *Longitudinal parenchyma* wanting. *Rays* of 2 types, uniseriate or in part biseriate, and fusiform; *(a)* uniseriate rays numerous *(t)* 1-15 plus cells in height; biseriate rays frequent in the areas of swirled tissue; *(b)* fusiform rays scattered or rarely 2-3 confluent along the grain in the swirled areas, with a transverse resin canal, 2-3-seriate through the central thickened portion, tapering above and below to uniseriate margins similar to the *(a)* rays, up to 15 plus cells in height; ray tracheids present in both types of rays, marginal and interspersed, prominently dentate with teeth frequently extending across the cell forming a reticulate pattern *(r);* marginal tracheids often in several rows; low rays frequently consisting entirely of ray tracheids; ray parenchyma thin-walled. *Resin canals* with thin-walled epithelium, frequently occluded with tylosoids in the heartwood; longitudinal canals with maximum diameter of 110 (avg 80-90) µm, the transverse canals much smaller (usually less than 50 µm).



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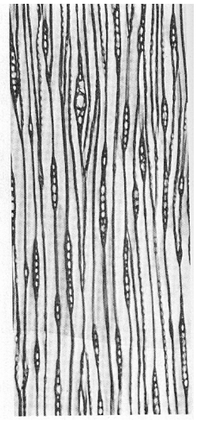

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Drying and Shrinkage

Wood shrinks as it dries, and swells as it absorbs moisture. Dimensional changes generally take place from 0% to 28% moisture content, based on its oven-dry weight. In a dry atmosphere, wet or "green" wood loses moisture in the form of water vapor. Dry wood, on the other hand, absorbs moisture from a humid atmosphere. The moisture content of wood also may be increased by wetting with liquid water. If wet wood is put into place, it eventually dries to a moisture content in equilibrium with the water vapor pressure of the surrounding air. This is the equilibrium moisture content (EMC). This drying is accompanied by shrinkage. If wood has been dried too far below the moisture content reached in use, it absorbs water until the equilibrium moisture content is achieved, and swelling results.

When changes in moisture content are great and occur quickly, shrinkage and swelling may cause, not only dimensional changes, but also splitting, cracking, glue-line failures, or other defects in woodwork, furniture and other wood products. Small changes that take place slowly usually cause very small, hardly noticeable dimensional changes. However, slight drying taking place over a fairly long period of time may generate cracks and distortions when wooden parts are severely restrained-for example, by mechanical fastenings such as staples, screws, nails, and bolts-so that shrinkage is inhibited. When drying stresses exceed the strength of either the wood itself or an adhesive bonding agent, failures will also occur, either in the wood itself or in the glue-lines.

	Percentage of shrinkage (green to final moisture content)		
Type of shrinkage	0% MC	6% MC	20% MC
Tangential	6.7	5.4	2.2
Radial	4.3	3.6	1.5
Volumetric	11.1	9.2	3.8

Physical and Mechanical Properties

	Moisture Content		
Property	Green	(12%)	Ovendry
SG	0.38	0.41	0.43
Weight (lb/ft^3)	39	29	NA
MOE (lb/in^2)	1,080,000	1,340,000	—
MOR (lb/in^2)	5,500	9,400	—
C (lb/in^2)	2,610	5,370	—
C ⊥ (lb/in^2)	250	610	—
WML (in-lb/in^3)	5.6	6.8	—
Shear (lb/in^2)	680	880	—
Tension ⊥ (lb/in^2)	220	290	—
Toughness (in-lb)	160	—	—
Hardness (lb)	330	480	—
Conductivity (Btu•in/h•ft^2•°F)	—	0.85	0.71
Resistivity (h•ft^2•°F/Btu•in)	—	1.2	1.4
Heat of combustion (Btu/lb)	-	-	8600
Flame Spread ASTM E-84	—	98	—

The values reported in this table are the results of tests on small clear specimens with moisture contents (MC) in the green, airdry and ovendry conditions. MC is the total amount of water in a given piece of wood and is expressed as a percentage of the ovendry weight of the wood. The ovendry weight is used as a basis because it is an indication of the amount of solid substance present. Solid wood substance is heavier than water, its specific gravity being about 1.5 regardless of species. Variation among species in the size of cells and in the thickness of cell walls affects the amount of solid wood substance present and, therefore, the specific gravity. Thus, specific gravity of wood is a measure of its solid wood substance and an index of its strength properties. Specific gravity is based on weight when ovendry and volume when green or at 12% moisture content.

Definition of properties: Modulus of elasticity measured from a simply supported, center-loaded beam, on a span depth ratio of 14/1. To correct for shear deflection, the modulus can be increased by 10%. impact bending is height of drop that causes complete failure, using 0.71-kg (50-lb) hammer; compression parallel to grain is also called

Continued on next page

Design Values for Visually Graded Structural Lumber

Lodgepole Pine		Extreme fiber in bending, "F_b"		Tension parallel to grain, "F_t"	Horizontal shear, "F_v"	Compression perpendicular to grain, "$F_{c\perp}$"	Compression parallel to grain, "F_c"	Modulus Of elasticity, "E"
Commercial grade	Size classification	Single member uses	Repetitive member uses					
Select structural	2" to 3" thick 2" to 4" wide	1500	1750	875	70	400	1150	1,300,000
No.1		1300	1500	750	70	400	900	1,300,000
No.2		1050	1200	625	70	400	700	1,200,000
No.3		600	675	350	70	400	425	1,000,000
Appearance		1300	1500	750	70	400	1050	1,300,000
Stud		600	675	350	70	400	425	1,000,000
Construction	2" to 4" thick 4" wide	775	875	450	70	400	800	1,000,000
Standard		425	500	250	70	400	675	1,000,000
Utility		200	225	125	70	400	425	1,000,000
Select structural	2" to 4" thick 5" and wider	1300	1500	875*	70	400	1000	1,300,000
No.1		1100	1300	750*	70	400	900	1,300,000
No.2		925	1050	475*	70	400	750	1,200,000
No.3		525	625	275*	70	400	475	1,000,000
Appearance		1100	1300	750*	70	400	1050	1,300,000
Stud		525	625	275*	70	400	475	1,000,000
Select structural	Beams and Stringers	1150	—	775	65	400	800	1,100,000
No.1		975	—	650	65	400	675	1,100,000
No.2		625	—	325	65	400	425	900,000
Select structural	Posts and Timbers	1100	—	725	65	400	850	1,100,000
No.1		875	—	600	65	400	725	1,100,000
No.2		500	—	350	65	400	350	900,000
Select	Decking	—	1550	(Surfaced at 15% maximum MC and used at 15% maximum MC)			—	1,400,000
Commercial		—	1300				—	1,200,000

The design values listed were reproduced from *Design Values for Wood Construction*, a supplement to the 1986 edition of the *National Design Specification for Wood Construction* by the American Forest and Paper Association (AFPA). This supplement is revise periodically, so the designer should check with AFPA for the latest information.

Design values listed are for normal loading conditions.

Surfaced dry or surfaced green; used at 19% maximum MC.

The design values shown are applicable to lumber that will be used under dry conditions such as in most covered structures. For 2" to 4" thick lumber, the dry surfaced size shall be used. In calculating design values, the natural gain in strength and stiffness that occurs as lumber dries has been taken into consideration as well as the reduction in size that that occurs when unseasoned lumber shrinks. The gain in load-carrying capacity due to increased strength and stiffness resulting from drying more than offset the design effect of size reduction due to shrinkage. For 5" and thicker lumber, the surfaced sizes also may be used because design values have been adjusted to compensate for any loss in size by shrinkage which may occur.

*Tabulated tension parallel to grain values for 5" and wider, 2 to 4" thick size classification apply to 5" and 6" widths only. For lumber wider than 6" the tabulated "F_t" values shall be multiplied by the following:

Grade	Multiply Tabulated F_t Values by 8"	10" and wider
Select Structural	0.90	0.80
No.1, No.2, No.3, & Appearance	0.80	0.60
Stud	—	—

Design values for Stud grade in 5" and wider size classifications apply to 5" and 6" widths only.

Values for F_b, F_t, and F_c for the grades of Construction, Standard, and Utility apply only to 4" widths. Design values for 2" and 3" widths of these grade are available from the Western Wood Products Association (WWPA).

The values in the table for dimension lumber 2 to 4" in thickness are based on edgewise use. When such lumber is used flatwise, the design values for extreme fiber in bending may be multiplied by the factors in the table to the right.

Dimension Lumber Used Flatwise	Thickness (in.)		
Width	2	3	4
2 in. to 4 in.	1.10	1.04	1.00
5 in. and wider	1.22	1.16	1.11

The design values for F_b for decking may be increased by 10% for 2" thick and 4% for 3" thick decking.

When 2" to 4" thick lumber is manufactured at a maximum MC of 15% and used in a condition where the MC does not exceed 15%, the design values may be multiplied by the following factors: F_b, 1.08; F_t, 1.08; F_v, 1.05 $F_{c\perp}$, 1.00; F_c, 1.17; and E, 1.05.

When 2" to 4" thick lumber is designed for use where the MC will exceed 19% for an extended period of time, design values shall be multiplied by the following: F_b, 0.86; F_t, 0.84; F_v, 0.97; $F_{c\perp}$, 0.67; F_c, 0.70; and E, 0.97.

When lumber 5" and thicker is designed for use where the MC will exceed 19% for an extended period of time, the design values shall be multiplied by the following factors: F_b, 1.00; F_t, 1.00; F_v, 1.00; $F_{c\perp}$, 0.67; F_c, 0.91; and E, 1.00.

When split, check or shake is absent from wide face of lumber, F_v may be multiplied by a factor of 2.00. When length of split, check or shake on wide face of lumber is known and no increase in them is anticipated, see NDS supplement for additional adjustments.

Stress rated boards of nominal 1", 1¼" and 1½" thickness, 2" and wider are permitted design values shown for Select Structural, No. 1, No. 2, No. 3, Construction, Standard, Utility, and Appearance grades as shown in the 2" to 4" thick category when graded in accordance with stress rated board provions in the grading rules (see WWPA).

When Decking graded to WWPA rules is surfaced at 15% maximum MC and used where the MC will exceed 15% for an extended period of time, the tabulated design values for Decking shall be multiplied by the following factors: F_b, 0.79; E, 0.92.

When the depth of a rectangular sawn lumber member 5" or thicker exceeds 12", the design value for F_b, shall be multiplied by the size factor, C_F, as determined by the following formula: $C_F = (12/d)^{1/9}$.