Selected Characteristics of Colorado Woods

Wood species	Paint-holding characteristic: Oil based paint	Paint-holding characteristic: Latex paint	Weathering: Resistance to cupping	Heartwood: Decay resistance	Heartwood: Ease of treating	Heartwood: 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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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: Ponderosa pine works easily using both hand and machine tools. It finishes and glues well, but the presence of knots makes painting difficult. It is resistant to splitting when nailed, but is rated average in nail holding ability.

Preservation: The sapwood is permeable to preservatives, and the heartwood is moderately resistant to preservative treatments.

Toxicity: In general, working with pine wood can cause dermatitis, allergic bronchial asthma, or rhinitis in some individuals.

Durability: Ponderosa pine is not durable under conditions favorable to decay unless treated with a preservative. The heartwood is slightly resistant to nonresistant to decay. 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

Ponderosa 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.

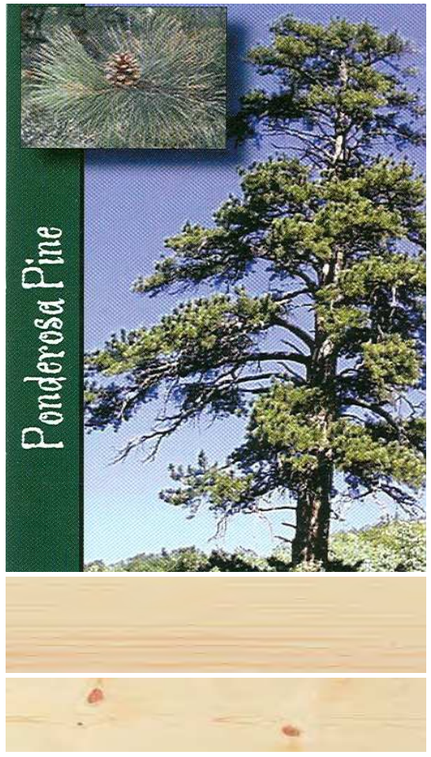
Inside Ponderosa Pine:

Colorado State University
Knowledge to Go Places

Colorado Woods

Ponderosa *Pine*

Pinus ponderosa



Description

The word *pinus* is the classical Latin name. The name *ponderosa* refers to ponderous, or heavy, referring to the wood.

The Tree: Ponderosa pine reaches heights of 180 ft with diameters of 4 ft. It has a pyramidal crown when young, maturing to a flat crown. The trees may live from 300 to 600 years.

Bark: Dark on young trees; nearly 3 inches thick, red-orange and furrowed into large flat scaly plates on mature trees.

Leaves: Evergreen needles are stiff, dark yellow-green; 3 to 7 inches long; typically in bundles of three that form tufts near the end of branches.

Fruit: Light red-brown cones; 3 to 4 inches long; egg-shaped with scales that are tipped by a sharp point; small long-winged seeds.

Elevation: 6,300 to 9,500 feet.

Habitat: Dry, nutrient poor soils in open park-like stands or with Douglas-fir, Rocky Mountain juniper and spruce.

Relation to Fire: Resistant to fire, due to open crowns, thick, insulating bark, self-pruning branches, high moisture content in the leaves and thick bud scales.

General Wood Characteristics

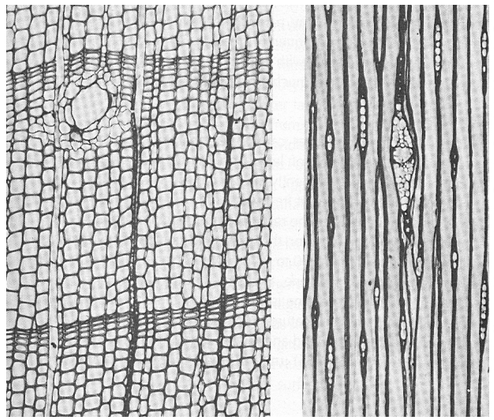
Botanically, ponderosa pine belongs to the yellow pine group rather than the white pine group. However, much of the wood is somewhat similar to the white pines in appearance and properties. The heartwood is yellowish to light reddish brown or orange, and the wide sapwood is nearly white to pale yellow. In young trees, the sapwood can make up more than half the volume; in older trees, the sapwood may be 2 in. or more wide. The wood of the outer portions of ponderosa pine of saw timber size is moderately light in weight, moderately low in strength, moderately soft, moderately stiff, and moderately low in shock resistance. Ponderosa pine is moderately weak in bending and endwise compression. It is straight grained (but can be dimpled on the tangential surface) and has moderately low shrinkage. It is quite uniform in texture and has little tendency to warp and twist.

Uses

Ponderosa pine is used mainly for lumber and, to a lesser extent, for piles, poles, posts, mine timbers, veneer, and railroad cross ties. The clear wood is especially well suited for *millwork* such as window frames, doors, shelving, trim, siding, paneling, and built-in case and cabinets because of its softness and uniformity of grain which permit accurate machining, and its moderately low shrinkage, ability to stay in place, resistance to abrasion, and attractive clear color (the difference between the color of the heart- and sapwood is accentuated upon exposure, necessitating care in matching the wood for interiors). Knotty ponderosa pine is used for *interior paneling* and for *building construction* (the heavier, wider-ringed, more resinous wood), as joists, rafters, studs, sills, and sheathing; *turned work* (porch columns, posts/balusters, stair rails). Lower grade lumber is used for *boxes, crates and pallets* for which it is well suited because of its light weight and color, ability to take nails and screws without splitting, strength to withstand rough handling, and freedom from objectionable odors and taste. Previously, much of the lumber of intermediate or lower grades was used for *wall sheathing, subflooring, and roofboards*. Most of this use has been replaced by plywood and OSB.

Minute Anatomy

Tracheids up to 60 (avg 35-45) µm in diameter; bordered pits in 1 row (occasionally in 2) on the radial walls; tangential pitting wanting in the last few rows of late-wood tracheids; pits leading to ray parenchyma pinoid, variable in shape and size, 1-7 (generally 4-5) per cross field. *Longitudinal parenchyma* wanting. *Rays* of 2 types, uniseriate and fusiform; *(a)* uniseriate rays numerous, 1-12 plus cells in height; *(b)* fusiform rays scattered, with a transverse resin canal, 3-5-seriate through the central thickened portion, tapering above and below to uniseriate margins similar to the *(a)* rays, up to 20 plus cells in height; ray tracheids present in both types of rays, marginal and occasionally interspersed, prominently dentate [the teeth frequently extending across the cell, forming a reticulate pattern]; 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 230 (avg 160-185) µm, the transverse canals much smaller (usually less than 70 µm). Dimpled ponderosa pine is sometimes confused with lodgepole pine which also contains this feature. Ponderosa pine differs from the later by possessing darker heartwood and larger longitudinal resin canals (160-185 µm) vs (80-90 µm).



x—75x

t—75x

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	6.2	5.0	2.1
Radial	3.9	3.1	1.3
Volumetric	9.7	7.7	3.2

Physical and Mechanical Properties

	Moisture Content		
Property	Green	(12%)	Ovendry
SG	0.38	0.40	0.42
Weight (lb/ft^3)	45	28	NA
MOE (lb/in^2)	1,000,000	1,290,000	—
MOR (lb/in^2)	5,100	9,400	—
C (lb/in^2)	2,450	5,320	—
C ⊥ (lb/in^2)	280	580	—
WML (in-lb/in^3)	5.2	7.1	—
Shear (lb/in^2)	700	1,130	—
Tension ⊥ (lb/in^2)	310	420	—
Toughness (in-lb)	190	150	—
Hardness (lb)	320	460	—
Conductivity (Btu•in/h•ft^2•°F)	—	0.84	0.69
Resistivity (h•ft^2•°F/Btu•in)	—	1.2	1.4
Heat of combustion (Btu/lb)	5670	8160	9140
Flame Spread ASTM E-84	—	115	—

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

Ponderosa 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		1400	1650	825	70	375	1050	1,200,000
No.1	2" to 3" thick 2" to 4" wide	1200	1400	700	70	375	850	1,200,000
No.2		1000	1150	575	70	375	675	1,100,000
No.3		550	625	325	70	375	400	1,000,000
Appearance		1200	1400	700	70	375	1000	1,200,000
Stud		550	625	325	70	375	400	1,000,000
Construction	2" to 4" thick 4" wide	725	825	425	70	375	775	1,000,000
Standard		400	450	225	70	375	625	1,000,000
Utility		200	225	100	70	375	400	1,000,000
Select structural	2" to 4" thick 5" and wider	1200	1400	825*	70	375	950	1,200,000
No.1		1050	1200	700*	70	375	850	1,200,000
No.2		850	975	450*	70	375	700	1,100,000
No.3		500	575	250*	70	375	450	1,000,000
Appearance		1050	1200	700*	70	375	1000	1,200,000
Stud		500	575	250*	70	375	450	1,000,000
Select structural	Beams and Stringers	1100	—	725	65	375	750	1,100,000
No.1		925	—	500	65	375	625	1,100,000
No.2		600	—	300	65	375	400	900,000
Select structural	Posts and Timbers	1000	—	675	65	375	800	1,100,000
No.1		825	—	550	65	375	700	1,100,000
No.2		475	—	325	65	375	325	900,000
Select	Decking	—	1450	(Surfaced at 15% maximum MC and used at 15% maximum MC)			—	1,300,000
Commercial		—	1250				—	1,100,000

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:

	Multiply Tabulated F_t Values by	
Grade	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: $C_F = (12/d)^{1/9}$.