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	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: White fir is easy to work and stays in place when properly dried. It paints and glues well and is moderate to moderately low in nail-holding ability.

Preservation: Considered difficult to penetrate with preservatives.

Toxicity: In general, working with white fir can cause dermatitis or eczema in some individuals.

Durability: 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

White Fir

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

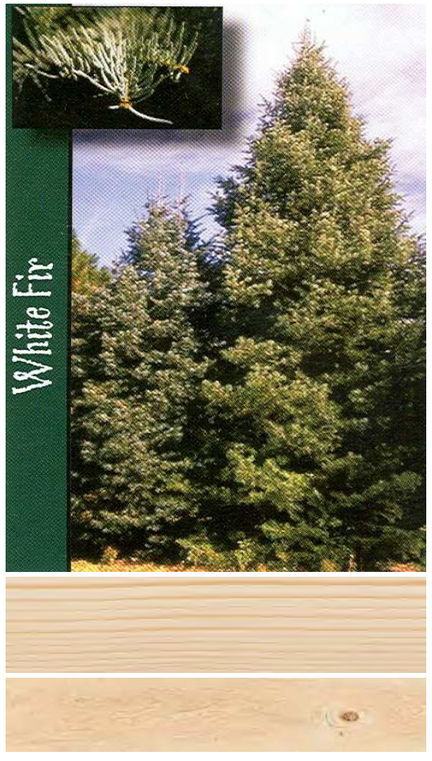
Wood is used in many forms throughout the world. However, few people fully understand the properties and peculiarities that must be considered for optimum application. This publication was developed as an aid for furthering the understanding of wood. It is a compilation of scientific and trade names, 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 White Fir:

Colorado Woods

White Fir

Abies concolor



Description

Abies is the classical Latin name of the silver fir (*Abies alba* Mill.) of Europe. The word *concolor* means of uniform color, referring to the needles, which are pale blue green on both surfaces.

The Tree: White fir trees reach heights of 60 to 125 ft with diameters of 4 ft.

Bark: Light gray and smooth with resin blisters on young trees; deeply furrowed into corky ridges and orange cracks when mature.

Leaves: Evergreen needles are tight blue-green or silvery with white lines on both surfaces; 1½ to 3 inches long; flat and rounded.

Fruit: Oblong, olive-green to blue cones; 3 to 5 inches long; upright on topmost twigs; fine, hairy cone scales; paired, long-winged seeds.

Elevation: 7,900 to 10,200 feet.

Habitat: Moist soils of high mountain valleys; in pure stands and with other firs.

Relation to Fire: Young are usually killed by low-intensity fires due to thin, resin blistered bark and drooping lower branches; mature trees are moderately fire tolerant.

General Wood Characteristics

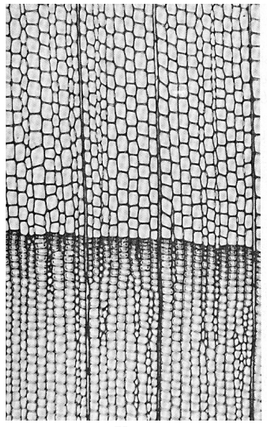
Wood whitish or light buff to yellowish brown or light brown, late-wood portion of the ring frequently with roseate, reddish brown, or lavender tinge *(heartwood* not distinct), without characteristic odor (sometimes with a slight disagreeable odor when green), tasteless, generally straight- and quite even-grained, medium- to somewhat coarse-textured, light, moderately soft easy to work, and stays in place when properly dried. It is moderate to moderately low in strength, stiffness, ability to resist shock, and nail withdrawal resistance. *Growth rings* distinct, delineated by a band of darker late wood, medium-wide to wide (3-4 per in) or narrow in the outer portion of mature trees. Early-wood zone usually occupying one-half or more of the ring; transition from early to late wood gradual; late-wood zone distinct to the naked eye, variable in depth of color and density according to conditions of growth, ranging from broad in wide rings to very narrow.

Uses

The tree is a favorite Christmas tree. Lumber of white fir is primarily used for general construction including rough and dressed boards, studs, and dimension timbers. In house construction, much of the lumber was used historically for subflooring, wall, and roof sheathing. Most of the sheathing uses have been replaced by plywood and OSB. White fir is well suited for boxes and crates because of its light weight, clean appearance, freedom from odors and stains, and relatively low cost. High-grade lumber is used mainly for general millwork products and other interior woodwork especially sashes, doors, trim, siding, and other planing-mill products. Some of the highest quality material is suitable for aircraft construction. Other special uses are venetian blinds and ladder rails. White fir is also used as pulpwood, primarily for printing paper and high-grade wrapping paper. Other applications for the wood include: plywood, prefabricated buildings, shook, furniture parts, and fruit and vegetable containers.

Minute Anatomy

Tracheids up to 60 (avg 35-45) µm in diameter; bordered pits in 1 row or occasionally biseriate on the radial walls; tangential pitting present in the last few rows of late-wood tracheids; pits leading to ray parenchyma taxodioid, small, quite uniform in size, with distinct border, 1-4 (generally 2-4) per cross field. *Longitudinal parenchyma* marginal and very sparse, or wanting. * *Rays* uniseriate, very variable in height (1-30 plus cells), consisting wholly of ray parenchyma; end walls nodular. Crystals are regularly found in the marginal parenchyma cells. *The strands of traumatic resinous cells, forming black streaks and termed *bird pecks*, that are sometimes found in the body of the ring as a transitional stage in the formation of longitudinal wound canals, are not interpreted here as true longitudinal parenchyma.



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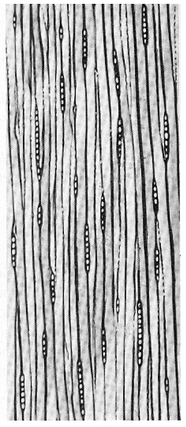

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Drying and Shrinkage

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	7.0	5.7	2.4
Radial	3.3	2.6	1.1
Volumetric	9.8	7.8	3.3

Physical and Mechanical Properties

	Moisture Content		
Property	Green	(12%)	Ovendry
SG	0.37	0.39	0.41
Weight (lb/ft^3)	47	26	NA
MOE (lb/in^2)	1,160,000	1,500,000	—
MOR (lb/in^2)	5,900	9,800	—
C (lb/in^2)	2,900	5,800	—
C ⊥ (lb/in^2)	280	530	—
WML (in-lb/in^3)	5.6	7.2	—
Shear (lb/in^2)	760	1100	—
Tension ⊥ (lb/in^2)	300	300	—
Toughness (in-lb)	160	—	—
Hardness (lb)	340	480	—
Conductivity (Btu•in/h•ft^2•°F)	—	0.82	0.68
Resistivity (h•ft^2•°F/Btu•in)	—	1.2	1.5
Heat of combustion (Btu/lb)	-	-	8300
Flame Spread ASTM E-84	—	65	—

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

White Fir		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	1650	1900	975	75	405	1300	1,500,000
No.1		1400	1600	825	75	405	1050	1,500,000
No.2		1150	1350	675	75	405	825	1,400,000
No.3		650	725	375	75	405	500	1,200,000
Appearance		1400	1600	825	75	405	1250	1,500,000
Stud		650	725	375	75	405	500	1,200,000
Construction	2" to 4" thick 4" wide	825	975	500	75	405	925	1,200,000
Standard		475	550	275	75	405	775	1,200,000
Utility		225	250	125	75	405	500	1,200,000
Select structural	2" to 4" thick 5" and wider	1400	1650	950*	75	405	1150	1,500,000
No.1		1200	1400	800*	75	405	1050	1,500,000
No.2		1000	1150	525*	75	405	875	1,400,000
No.3		575	675	300*	75	405	550	1,200,000
Appearance		1200	1400	800*	75	405	1250	1,500,000
Stud		575	675	300*	75	405	550	1,200,000
Select structural	Beams and Stringers	1250	—	850	70	405	925	1,300,000
No.1		1050	—	725	70	405	775	1,300,000
No.2		675	—	325	70	405	475	1,100,000
Select structural	Posts and Timbers	1200	—	800	70	405	975	1,300,000
No.1		950	—	650	70	405	850	1,300,000
No.2		525	—	350	70	405	375	1,100,000
Select	Decking	—	1700	(Surfaced at 15% maximum MC and used at 15% maximum MC)			—	1,600,000
Commercial		—	1450				—	1,400,000

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: $C_F = (12/d)^{1/9}$.