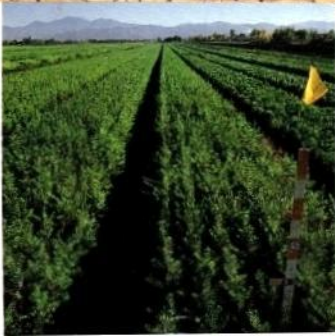




Western Lumber Product Use Manual



**WESTERN WOOD
PRODUCTS ASSOCIATION**




BASE VALUES
for dimension lumber

Introduction

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WESTERN WOOD PRODUCTS ASSOCIATION

The Western Wood Products Association is a lumber trade association that represents the solid-sawn lumber products of its member companies in 13 western states. WWPA is an American Lumber Standard (ALS) -approved, rules-writing agency — the largest grading agency under the jurisdiction of the ALS Committee, and the largest trade association of its kind in the world. Services include:

Quality Standards - the *Western Lumber Grading Rules* and quality control supervision in the field.

Economic Services - statistical reporting and consumption data for the Western Lumber industry.

Technical Services - wood engineering, research and technology.

Marketing Services - product promotion and educational services with professional field representatives located throughout the U.S. and in specific market areas overseas.

Association services are available to engineers, architects, specifiers, contractors, building regulators, universities and community colleges, lumber wholesalers and retailers. If you need assistance with Western Lumber products, telephone the Portland office and ask for Field Services, 503/224-3930.

COLOR CODES IN THIS MANUAL

Western solid-sawn lumber is grouped into three broad categories: framing (or structural) lumber, which is graded for strength; appearance lumber, which is not graded for strength; and industrial (or factory) lumber, which is graded for specific end uses or for remanufacturing and recovery purposes. All information related to using and specifying products within these broad categories is color-coded for your convenience:



Framing
Lumber



Appearance
Lumber



Industrial
Lumber

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Western Wood Products Association

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Western Species

WESTERN WOODS REGION

There are 136 million forested acres in the Western Woods Region, approximately 67% of the US's standing volume of sawtimber.

Forested lands are just that; however, **timberlands*** are those forested lands designated for multiple use, including timber for products. **Timberlands do not include forested lands formally set aside** in national parks or as wilderness, wildlife preserves and other reserved areas. These forested lands are managed differently and **are permanently protected from harvesting.**

Much of the West's **timberland** is publicly owned. National forests comprise 52% of the region's timberland base with another 10% also publicly owned, but managed by agencies other than the USDA Forest Service. Some 25% is privately owned by non-industrial individuals and companies. The remaining 13% is owned by forest products companies.

Between the early 1900s and 1987, some 20 million forested acres in the West were set aside, in their natural state, in perpetuity. By 1993, a total of 48 million acres had been effectively set aside, as harvesting was prohibited or highly restricted on more than 80% of the region's national forests (59.8 million acres in the West). Proposed set asides, under the Clinton administration's Forest Plan, represent further withdrawals from both publicly- and privately-owned timberlands.

Traditionally, Western Lumber has provided 60% or more of US production, rising and falling in response to market demand. However in 1993, due to the effects of political and/or judicial decisions, it accounted for less than 52%. Meanwhile, production from the South and Canada increased to record volumes to meet US demand.

The impacts of setting aside managed timberlands are manifold. When the supply base of a basic raw material is radically reduced either as a result of depletion, natural causes or war, or as a result of special interests, as is the case with western timberlands, there is a chain reaction.

Demand and supply become unbalanced, product availability becomes unstable, prices become volatile. New sources of supply are sought, and alternative materials and products respond accordingly with new economic and environmental impacts.

Lumber requires less energy and generates fewer air and water emissions than any other building material. Wood products come from a renewable resource that absorbs carbon dioxide as it grows, storing it in the fiber of the tree where it remains locked even after it is made into products. The resource is 100% utilized for a variety of products that are strong, beautiful, utilitarian, non-toxic and naturally insulating. When products have performed their useful life and are left exposed to air and water, they biodegrade into life-supporting, organic dirt. No other product is kinder to the environment.

However, the availability of wood products depends on a supply base of a predictable size, coupled with harvesting and production management that can respond to the ebb and flow of the marketplace as 30- to 150-year management plans for a variety of forest values are implemented.

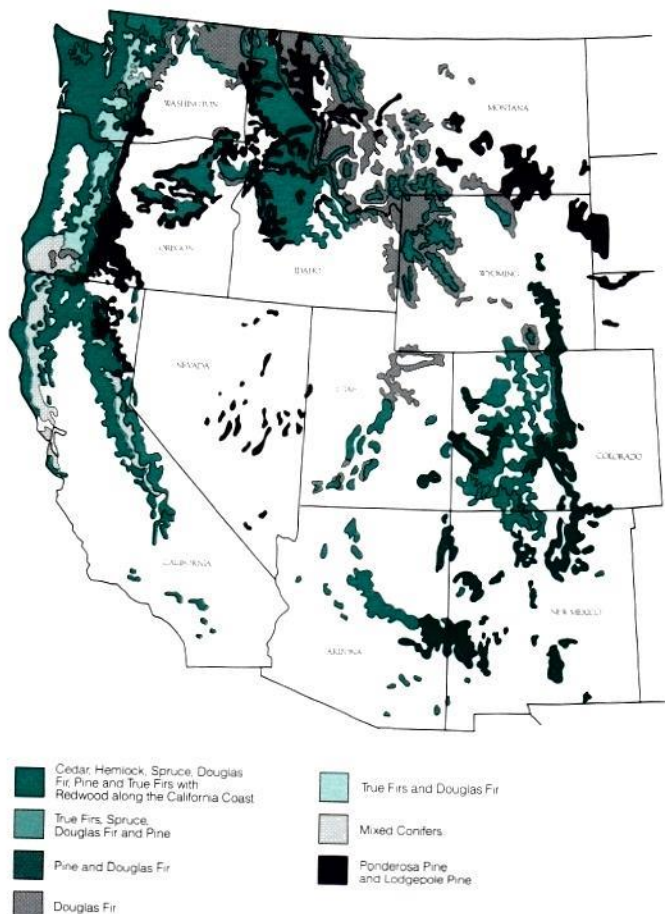
The western region holds two thirds of the nation's forest inventory, growth exceeds harvest by more than 34%, and timberland management practices are among the most rigorous of anywhere in the world.

The member companies of Western Wood Products Association are committed to perpetuating America's forests for products and the environment, and they have submitted their Western Lumber products to a life-cycle environmental audit by an independent third party, Scientific Certification Systems, Inc. Results are expected in Spring, 1995.

SPECIES GROUPINGS

There are more than 15 commercially important western softwood species. The lumber from several of the western softwood species shares performance properties and is similar enough in appearance that many species are grouped together into "Marketing Categories." The species within these categories are often harvested, manufactured and sold interchangeably in the marketplace.

Western Lumber may be bought, sold and specified as separate species or according to the species groups, or "Marketing Categories," shown on the map below and outlined on the following page.



*Note: Timberland is forestland that is producing or is capable of producing crops of industrial wood and not withdrawn from timber utilization by statute or administrative regulation. The term "Timberland" replaces "Commercial Forestland" in USDA Forest Service terminology.

Species Groups & Grades

MARKETING CATEGORIES

STANDARD SPECIES COMBINATIONS		WESTERN SOFTWOOD SPECIES		ALTERNATE COMBINATIONS (species of lowest assigned design value governs combination)		
Western Woods	DOUG. FIR-L	Douglas Fir-Larch	Douglas Fir — <i>Pseudotsuga menziesii</i>			
	D FIR S	Douglas Fir-South	Douglas Fir-South — <i>Pseudotsuga menziesii</i> (Grown in AZ, CO, NV, NM & UT)	Western Larch — <i>Larix occidentalis</i>		
	HEM FIR	Hem-Fir	Western Hemlock — <i>Tsuga heterophylla</i>	Noble Fir — <i>Abies procera</i>		
			California Red Fir — <i>Abies magnifica</i>			
			Grand Fir — <i>Abies grandis</i>			
			Pacific Silver Fir — <i>Abies amabilis</i>			
			White Fir — <i>Abies concolor</i>			
			Sitka Spruce — <i>Picea sitchensis</i>			
			Engelmann Spruce — <i>Picea engelmannii</i>	Engelmann Spruce-Lodgepole Pine	Engelmann Spruce-Alpine Fir	
			Lodgepole Pine — <i>Pinus contorta</i>	Alpine Fir-Hem-Fir	Engelmann Spruce-Lodgepole Pine-Alpine Fir	
	SPF S	Spruce-Pine-Fir (South)	Alpine Fir — <i>Abies lasiocarpa</i> (or Subalpine Fir)	Alpine Fir-Hem-Fir		
			Ponderosa Pine — <i>Pinus ponderosa</i>	Ponderosa Pine-Lodgepole Pine		
	WEST WOODS	Western Woods	Sugar Pine — <i>Pinus lambertiana</i>			
			Idaho White Pine — <i>Pinus monticola</i> (or Western White Pine)			
			Mountain Hemlock — <i>Tsuga mertensiana</i>			
			Incense Cedar — <i>Libocedrus decurrens</i>			
	WEST CDR	Western Cedars	Western Red Cedar — <i>Thuja plicata</i>			
			Port Orford Cedar — <i>Chamaecyparis lawsoniana</i>			
			Alaskan Cedar — <i>Chamaecyparis nootkatensis</i>			

WW

GRADE CATEGORIES

Framing Lumber includes the grades intended for structural applications in both conventional and pre-engineered framing systems. Western species structural lumber is manufactured primarily from second- and third-growth softwoods and graded, either visually or mechanically, on the basis of its strength; each species and grade has an assigned design value. General classifications include:

- Dimension Lumber Grades
- Special Dimension Lumber Grades
- Timber Grades

Design values for Dimension Lumber are published as BASE VALUES which must be adjusted for size as well as conditions of use. Refer to pages 5 to 17, the ■-tinted information.

Appearance Lumber includes a variety of non-structural grades intended for applications where strength is not the primary consideration. Appearance grade Western Lumber is manufactured primarily from older (not "old-growth") and second-growth softwood trees. Many of the products in this category are often run-to-pattern for paneling and siding applications. General classifications for Appearance Lumber include:

- High Quality Appearance Grades
(Selects, Finish and Special Western Red Cedar Grades)
 - General Purpose Boards
(Commons under WWPB Rules and Alternate Board Grades under WCLIB Rules)
 - Radius-edged Patio Decking Grades
(Patio 1 and Patio 2)
- Refer to pages 18 to 20, ■-tinted information.

Industrial Lumber includes both structural and non-structural grades that are intended for specific applications. General classifications include:

- Structural Grades
(Mining Timbers, Scaffold Plank, Foundation Lumber & Stress-Rated Boards)
 - Factory & Shop Grades
(non-structural grades intended for cut up and remanufacturing)
 - Non-Structural Grades
(Gutter, Picket, Lath, Batten, Stepping)
- Refer to pages 21 & 22, ■-tinted information.

Framing Lumber

WWPA GRADE STAMPS

Grading practices of WWPA member mills are closely supervised by the Association's field team of Lumber Inspectors to assure uniformity and conformance to the *Western Lumber Grading Rules*.


The *Grading Rules* provide the specifier with a dependable measure for determining the quality of lumber. Western Lumber grades may be assigned visually or mechanically.

The building codes require that grade-marked lumber be used for structural applications. If practical, appearance grades such as Boards, Commons, siding, paneling, soffit, etc. can be specified end-stamped. Most grade stamps, except those for rough lumber or heavy timbers, contain the five basic elements shown below:



a. WWPA Certification

Mark: Certifies Association quality supervision.

 is a registered trademark.

b. Mill Identification:

Firm name, brand or assigned

mill number. WWPA can be contacted to identify an individual mill whenever necessary.

c. Grade Designation:

Grade name, number or abbreviation.

d. Species Identification:

Indicates species by individual species or species combination. Other species identification marks are shown in the species list on page 4.

e. Condition of Seasoning:

Indicates condition of seasoning at time of surfacing—

MC-15 or KD-15 - 15% maximum moisture content

S-DRY or KD - 19% maximum moisture content

S-GRN - over 19% moisture content (unseasoned)

The Association's *Western Lumber Grading Rules* establishes standards of size and levels of quality in conformance with the American Softwood Lumber Standards *PS 20-94*. The Association is certified as a rules-writing and inspection agency by the Board of Review, American Lumber Standards Committee. The Association is approved to provide mill supervisory services under its rules and the rules of the Redwood Inspection Service (RIS), the West Coast Lumber Inspection Bureau (WCLIB), the National Lumber Grades Authority for Canadian Lumber, the Pacific Lumber Inspection Bureau (PLIB) Export R-List Rules and the National Grading Rule (NGR) portion of the Southern Pine Inspection Bureau Rules. In addition, WWPA is approved to supervise end-jointed and machine stress-rated lumber.

In addition, the Association is recognized by the Japanese Ministry of Agriculture, Forestry, and Fisheries (MAFF) as a Foreign Testing Organization (FTO) and can certify mills and provide quality control supervision for Japanese Dimension grades under JAS 600 and Japanese MSR grades.

DESIGN VALUE DERIVATIONS

Design values for North American softwood structural lumber are computed in accordance with ASTM standards based on clear-wood tests or on tests of full-size pieces in specific grades. The applicable standards, based on results of tests conducted in cooperation with the U.S. Forest Products Laboratory, are *ASTM Standards D 2555* and *D 245* for clear

wood, and *D 1990* for full-size test specimens. Refer to Sections 100 to 170 of the *Western Lumber Grading Rules* for additional information.

FRAMING LUMBER

Introduction - The general classifications of Framing Lumber are Dimension Lumber, Special Dimension and Timbers. All information related to structural Framing Lumber is color-coded with ■ for easy reference. The lumber grades within these classifications are intended for structural applications in load-bearing situations.

The design values in Table 1 are published as **BASE VALUES**. **BASE VALUES** are constants that are applied to each grade in a particular species grouping. **BASE VALUES** must be adjusted for size, using the **SIZE-ADJUSTMENT FACTORS** in Table A. Design values in Tables 3, 4 and 5 are published in a **SIZE-ADJUSTED FORMAT**, and no size adjustment is necessary. All design values (in Tables 1-5) must be adjusted for conditions of use (Tables B-G) as appropriate. Refer to page 8 for more information on using **BASE VALUES**. The checklists, after each classification of lumber, serve as reminders as to when and how to apply adjustments to the numbers in each table of design values.

Physical Properties - Lumber strength properties are assigned to five basic properties: fiber stress in bending (F_b), tension parallel-to-grain (F_t), horizontal shear (F_v), compression perpendicular-to-grain ($F_{c\perp}$) and compression parallel-to-grain ($F_{c\parallel}$). The modulus of elasticity (E or MOE) is a ratio of the amount a piece of lumber will deflect in proportion to an applied load. It is a measurement of stiffness and not a strength property. Refer to page 12 for a description of these properties.

Western Lumber design values are for use in all normal construction design. Higher or lower design values may be used to meet special structural requirements. Standard ASTM reductions have been made to the strength values to account for safety and duration of load. The *National Design Specification for Wood Construction (NDS)*, published by the American Forest & Paper Association, 1111 19th Street, NW, Eighth Floor, Washington, DC 20036, sets forth design methods for normal and most special structural applications.

Moisture Content - Any of the abbreviations, MC-15, KD-15, S-DRY, KD or S-GRN may be found in a grade stamp to denote the moisture content (MC) of lumber at the time of surfacing. Designations are explained in the left column.

Unseasoned (S-GRN) lumber is manufactured oversized so that when it reaches 19% MC it will be approximately the same size as the dry size. Therefore, when unseasoned lumber is shipped, the same design values that are assigned and used for dry lumber also apply to S-GRN lumber.

The word "DRY" indicates that a product was either kiln- or air-dried to a moisture content specified by grade.

Framing Lumber, 2" and less in thickness, can be seasoned to a moisture content of 19% or less, with the indication "S-DRY" or "KD" on the grade stamp. Surfaced framing lumber, over 2" in thickness, is typically shipped unseasoned and indicated "S-GRN" on the grade stamp. Regional market conditions dictate the availability of dry or unseasoned material.

Framing Lumber



BASE VALUES FOR WESTERN DIMENSION LUMBER*

Table 1

Sizes: 2" to 4" thick by 2" and wider

USE WITH APPROPRIATE ADJUSTMENTS IN TABLES A THROUGH G

Grades Described in *Western Lumber Grading Rules*, Sections 40.00, 41.00, 42.00 & 62.00

Also Stress Rated Boards, See Section 30.60

Species or Group	Grade	Extreme Fiber Stress in Bending "F _b " Single	Tension Parallel to Grain "F _t "	Horizontal Shear "F _v "	Compression		Modulus of Elasticity "E"
					Perpendicular "F _c ⊥"	Parallel to Grain "F _c //"	
Douglas Fir-Larch <i>Douglas Fir</i> <i>Western Larch</i>	Select Structural	1450	1000	95	625	1700	1,900,000
	No. 1 & Btr.	1150	775	95	625	1500	1,800,000
	No. 1	1000	675	95	625	1450	1,700,000
	No. 2	875	575	95	625	1300	1,600,000
	No. 3	500	325	95	625	750	1,400,000
	Construction	1000	650	95	625	1600	1,500,000
	Standard	550	375	95	625	1350	1,400,000
	Utility	275	175	95	625	875	1,300,000
Stud	675	450	95	625	825	1,400,000	
Douglas Fir-South <i>Douglas Fir South</i>	Select Structural	1300	875	90	520	1550	1,400,000
	No. 1	900	600	90	520	1400	1,300,000
	No. 2	825	525	90	520	1300	1,200,000
	No. 3	475	300	90	520	750	1,100,000
	Construction	925	600	90	520	1550	1,200,000
	Standard	525	350	90	520	1300	1,100,000
	Utility	250	150	90	520	875	1,000,000
	Stud	650	425	90	520	825	1,100,000
Hem-Fir <i>Western Hemlock</i> <i>Noble Fir</i> <i>California Red Fir</i> <i>Grand Fir</i> <i>Pacific Silver Fir</i> <i>White Fir</i>	Select Structural	1400	900	75	405	1500	1,600,000
	No. 1 & Btr.	1050	700	75	405	1350	1,500,000
	No. 1	950	600	75	405	1300	1,500,000
	No. 2	850	500	75	405	1250	1,300,000
	No. 3	500	300	75	405	725	1,200,000
	Construction	975	575	75	405	1500	1,300,000
	Standard	550	325	75	405	1300	1,200,000
	Utility	250	150	75	405	850	1,100,000
Stud	675	400	75	405	800	1,200,000	
Spruce-Pine-Fir (South) <i>Western Species:</i> <i>Engelmann Spruce</i> <i>Sitka Spruce</i> <i>Lodgepole Pine</i>	Select Structural	1300	575	70	335	1200	1,300,000
	No. 1	850	400	70	335	1050	1,200,000
	No. 2	750	325	70	335	975	1,100,000
	No. 3	425	200	70	335	550	1,000,000
	Construction	850	375	70	335	1200	1,000,000
	Standard	475	225	70	335	1000	900,000
	Utility	225	100	70	335	650	900,000
	Stud	575	250	70	335	600	1,000,000
Western Cedars <i>Western Red Cedar</i> <i>Incense Cedar</i> <i>Port Orford Cedar</i> <i>Alaska Cedar</i>	Select Structural	1000	600	75	425	1000	1,100,000
	No. 1	725	425	75	425	825	1,000,000
	No. 2	700	425	75	425	650	1,000,000
	No. 3	400	250	75	425	375	900,000
	Construction	800	475	75	425	850	900,000
	Standard	450	275	75	425	650	800,000
	Utility	225	125	75	425	425	800,000
	Stud	550	325	75	425	400	900,000
Western Woods <i>Any of the species in the first four species groups above plus any or all of the following:</i> <i>Idaho White Pine</i> <i>Ponderosa Pine</i> <i>Sugar Pine</i> <i>Alpine Fir</i> <i>Mountain Hemlock</i>	Select Structural	875	400	70	335	1050	1,200,000
	No. 1	650	300	70	335	925	1,100,000
	No. 2	650	275	70	335	875	1,000,000
	No. 3	375	175	70	335	500	900,000
	Construction	725	325	70	335	1050	1,000,000
	Standard	400	175	70	335	900	900,000
	Utility	200	75	70	335	600	800,000
	Stud	500	225	70	335	550	900,000

*Design values in pounds per square inch.

Framing Lumber



ADJUSTMENT FACTORS FOR BASE VALUES

SIZE FACTORS (C_F)

Table A

Apply to Dimension Lumber Base Values

Grades	F _b			F _t	F _{C//}	Other Properties
	Nominal Width (depth)	2" & 3" thick nominal	4" thick nominal			
Select Structural, No. 1 & Btr., No. 1, No. 2 & No. 3	2", 3" & 4"	1.5	1.5	1.5	1.15	1.0
	5"	1.4	1.4	1.4	1.1	1.0
	6"	1.3	1.3	1.3	1.1	1.0
	8"	1.2	1.3	1.2	1.05	1.0
	10"	1.1	1.2	1.1	1.0	1.0
	12"	1.0	1.1	1.0	1.0	1.0
	14" & wider	0.9	1.0	0.9	0.9	1.0
Construction & Standard	2", 3" & 4"	1.0	1.0	1.0	1.0	1.0
Utility	2" & 3"	0.4	—	0.4	0.6	1.0
	4"	1.0	1.0	1.0	1.0	1.0
Stud	2", 3" & 4"	1.1	1.1	1.1	1.05	1.0
	6" & wider	1.0	1.0	1.0	1.0	1.0

REPETITIVE MEMBER FACTOR (C_r)

Table B

Apply to Size-adjusted F_b

Where 2" to 4" thick lumber is used repetitively, such as for joists, studs, rafters and decking, the pieces side by side share the load and the strength of the entire assembly is enhanced. Therefore, where three or more members are adjacent or are not more than 24" on center and are joined by floor, roof or other load distributing elements, the F_b value can be increased 1.15 for repetitive member use.

REPETITIVE MEMBER USE

$$F_b \times 1.15$$

DURATION OF LOAD ADJUSTMENT (C_D)

Table C

Apply to Size-adjusted Values

Wood has the property of carrying substantially greater maximum loads for short durations than for long durations of loading. Tabulated design values apply to normal load duration. (Factors do not apply to MOE or F_{C⊥}.)

LOAD DURATION	FACTOR
Permanent	0.9
Ten Years (Normal Load)	1.0
Two Months (Snow Load)	1.15
Seven Day	1.25
One Day	1.33
Ten Minutes (Wind and Earthquake Loads)	1.6
Impact	2.0

Confirm load requirements with local codes. Refer to Model Building Codes or the National Design Specification for high-temperature or fire-retardant treated adjustment factors.

HORIZONTAL SHEAR ADJUSTMENT (C_H)

Table D

Apply to F_v Values

Horizontal shear values published in Tables 1, 3, 4 & 5 are based upon the maximum degree of shake, check or split that might develop in a piece. When the actual size of these characteristics is known, the following adjustments may be taken.

2" THICK LUMBER		3" and THICKER LUMBER	
For convenience, the table below may be used to determine horizontal shear values for any grade of 2" thick lumber in any species when the length of split or check is known and any increase in them is not anticipated:		Horizontal shear values for 3" and thicker lumber also are established as if a piece were split full length. When specific lengths of splits are known and any increase in them is not anticipated, the following adjustments may be applied.	
When length of split on wide face is:	Multiply Tabulated F _v value by:	When length of split on wide face is:	Multiply Tabulated F _v value by:
No split	2.00	No split	2.00
1/2 of wide face	1.67	1/2 of narrow face	1.67
3/4 of wide face	1.50	1 of narrow face	1.33
1 of wide face	1.33	1 1/2 of narrow	1.00
1 1/2 of wide face or more	1.00	or more	

ADJUSTMENTS FOR DIMENSION LUMBER

Checklist 1

Refer to page 8 for information on using the BASE VALUES in Table 1.

The boxes in the checklist below indicate when and how to apply adjustments (Tables A-G) to the BASE VALUES in Table 1.

BASE VALUES	ADJUSTMENT FACTORS					SPECIAL USE FACTORS			=	DESIGN VALUES
	Size C _F	Repetitive Member C _r	Duration of Load C _D	Shear C _H	Flat Use C _{tu}	Compression Perpendicular C _{C⊥}	Other: Wet Use Temperature Fire-Retardant C _M , C _t , C _R	Design Value		
F _b	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>			<input type="checkbox"/>		<input type="checkbox"/>		F' _b Bending
F _t	<input type="checkbox"/>		<input type="checkbox"/>					<input type="checkbox"/>		F' _t Tension
F _v			<input type="checkbox"/>	<input type="checkbox"/>				<input type="checkbox"/>		F' _v Shear
F _{C⊥}							(See Table F)	<input type="checkbox"/>		F' _{C⊥} Compression Perpendicular
F _{C//}	<input type="checkbox"/>		<input type="checkbox"/>					<input type="checkbox"/>		F' _{C//} Compression Parallel
E								<input type="checkbox"/>		E' Stiffness
Table 1	Table A	Table B	Table C	Table D	Table E	Table F	Table G & NDS			

Framing Lumber



DIMENSION LUMBER

Sizes/Design Values - Dimension Lumber includes products that are nominal 2" to 4" in thickness by 2" and wider. It is available in the grades listed in Table 1 (page 6) with assigned design values published as BASE VALUES.

Dimension Lumber BASE VALUES must be adjusted for size as well as conditions of use. Adjust the BASE VALUE (Table 1, page 6) according to the correct factor for size (Table A, page 7) before adjusting for conditions of use.

Single member, size-adjusted fiber stress in bending (F_b) design value is for use where the strength of an individual piece, such as a small beam or post is or may be responsible for carrying a specific design load. Repetitive member use is handled through an adjustment factor, Table B, page 7.

Using BASE VALUES - Dimension lumber values are published as BASE VALUES in Table 1, page 6. BASE VALUES must first be adjusted for size (Table A, page 7) and then for conditions of use (Tables B-D, page 7 and Tables E-H, page 9). The most common condition-of-use adjustments, Repetitive Member, Duration of Load and Horizontal Shear are shown with the SIZE ADJUSTMENT FACTORS on the preceding page. The adjustments for more specific conditions of use, such as Flat Use, Compression Perpendicular, Wet Use and others are presented on the page 9. **Checklist 1, on page 7, provides a quick reference to all of the adjustments applicable to dimension lumber BASE VALUES.** Once all appropriate adjustments are taken, the adjusted number becomes the design value for a specific piece in its application. Formulas for BASE VALUES are provided below.

Note: The basic difference between using BASE VALUES and the design values that were published for dimension lumber prior to the results of the In-Grade Testing Program, is that BASE VALUES must be adjusted for SIZE before conditions of use.

BASE VALUE EQUATIONS

Apply to Dimension Lumber Values in Table 1

Base Value	x	Size Adjustment Factor	x	Routine Adjustment Factors	x	Special Use Factors	=	Design Value	
F_b	x	C_F	x	C_D	x	C_R	x	C_M x C_{Fu}	= F_b
F_t	x	C_F	x	C_D	x	C_R	x	C_M x C_t	= F_t
F_v			x	C_D	x	C_H	x	C_M x C_R x C_t	= F_v
$F_{c\perp}$ *					x	C_M x C_R x C_t	=	$F_{c\perp}$	
$F_{c\parallel}$	x	C_F	x	C_D	x	C_M x C_R x C_t	=	$F_{c\parallel}$	
E					x	C_M x C_R x C_t	=	E'	

* For $F_{c\perp}$ value of 0.02" deformation basis, see Table F.

Note: C_F = Size Factor
 C_R = Repetitive Member Factor
 C_H = Horizontal Shear
 C_D = Duration of Load
 C_{Fu} = Flat Use Factor
 C_M = Wet Use Factor
 C_R = Fire Retardant Factor, refer to the National Design Specification
 C_t = Temperature Factor, refer to the National Design Specification

Grades/End-Uses - Dimension lumber (2" to 4" thick by 2" and wider) is available in the nine grades listed in Table 1 with BASE VALUES assigned to each grade in a species group. The grades are organized in the National Grading Rule (NGR) as Structural Light Framing, Light Framing, Stud and Structural Joists & Planks. These categories are related to size and strength as well as intended end uses.

2x2 through 4x4 - These sizes are available in the Structural Light Framing, Light Framing and Stud strength categories.

Structural Light Framing grades in 2x2 through 4x4 are intended to fit engineering applications where highest design values are needed in light framing sizes. A mix of SELECT STRUCTURAL and NO. 1 may be gradestamped as NO. 1 & BTR in Douglas Fir, Douglas Fir-Larch or Hem-Fir. Typical uses include trusses, concrete forms, engineered applications, etc. (Numbers in parentheses below are references to paragraph numbers in the *Western Lumber Grading Rules*.)

Structural Light Framing (SLF) grades are:

SELECT STRUCTURAL	(42.10)
NO. 1	(42.11)
NO. 2	(42.12)
NO. 3	(42.13)

Light Framing grades in 2x2 through 4x4 are intended for use where high strength values are not required, such as for wall framing, plates, sills, cripples, blocking, etc.

Light Framing (LF) grades are:

CONSTRUCTION	(40.11)
STANDARD	(40.12)
UTILITY	(40.13)

2x2 through 4x14 - Products within this category can be graded as STUD grade. It is an optional all-purpose grade limited to 10' and shorter. Characteristics affecting strength and stiffness values are limited so that **STUD grade** is suitable for stud uses, including load bearing walls.

STUD	(41.13)
------	---------

2x5 through 4x18 - These sizes, categorized in the NGR as Structural Joists and Planks, are intended to fit engineering applications for lumber 5" and wider, such as floor joists, rafters, headers, small beams, trusses and general framing uses. A mix of SELECT STRUCTURAL and NO. 1 may be gradestamped NO. 1 & BTR J&P in Douglas Fir, Douglas Fir-Larch or Hem-Fir.

Structural Joists and Planks (SJ&P) grades are:

SELECT STRUCTURAL	(62.10)
NO. 1	(62.11)
NO. 2	(62.12)
NO. 3	(62.13)

STRUCTURAL GLUED LUMBER PRODUCTS

U.S. Model Building Codes have approved the same design values for both solid-sawn Dimension Lumber and Structural Glued Lumber products.

Currently WWPA certifies the manufacture of structurally glued dimension lumber in various species and grades under the following classifications: Light Framing and Studs, Structural Light Framing, Decking, Stress-Rated Boards, and Structural Joists and Planks. A WWPA grade stamp is issued and used only if the material complies with all applicable sections of WWPA's *Glued Products Procedures for Certification and Quality Control*. Order WWPA's *Technical Information Product Sheet, Structural Glued Lumber (TG-9)* for additional information.



ADDITIONAL ADJUSTMENT FACTORS FOR DIMENSION LUMBER

FLAT USE FACTORS (C_{fu}) Table E

Apply to Size-adjusted F_b

NOMINAL WIDTH	NOMINAL THICKNESS	
	2" & 3"	4"
2" & 3"	1.00	—
4"	1.10	1.00
5"	1.10	1.05
6"	1.15	1.05
8"	1.15	1.05
10" & wider	1.20	1.10

ADJUSTMENTS FOR COMPRESSION PERPENDICULAR-TO-GRAIN ($C_{c\perp}$) Table F

For Deformation Basis of 0.02"

Apply to $F_{c\perp}$ Values

Design values for compression perpendicular-to-grain ($F_{c\perp}$) are established in accordance with the procedures set forth in ASTM Standards D 2555 and D 245. ASTM procedures consider deformation under bearing loads as a serviceability limit state comparable to bending deflection because bearing loads rarely cause structural failures. Therefore, ASTM procedures for determining compression perpendicular-to-grain values are based on a deformation of 0.04" and are considered adequate for most classes of structures. Where more stringent measures need to be taken in design, the following formula permits the designer to adjust design values to a more conservative deformation basis of 0.02":

$$Y_{02} = 0.73 Y_{04} + 5.60$$

EXAMPLE: Douglas Fir-Larch, $Y_{04} = 625$ psi
 $Y_{02} = 0.73(625) + 5.60 = 462$ psi

WET USE FACTORS (C_M) Table G

Apply to Size-adjusted Values

The design values shown in the accompanying tables are for routine construction applications where the moisture content of the wood does not exceed 19%. When use conditions are such that the moisture content of dimension lumber will exceed 19%, the Wet Use Adjustment Factors below are recommended:

PROPERTY	ADJUSTMENT FACTOR
F_b Extreme Fiber Stress in Bending	0.85*
F_t Tension Parallel-to-Grain	1.0
F_c Compression Parallel-to-Grain	0.8**
F_v Horizontal Shear	0.97
$F_{c\perp}$ Compression Perpendicular-to-Grain	0.67
E Modulus of Elasticity	0.9

*Wet Use Factor 1.0 for size-adjusted F_b not exceeding 1150 psi.

**Wet Use Factor 1.0 for size-adjusted F_c not exceeding 750 psi.

SPECIAL DIMENSION LUMBER

Grades/End Uses - There are two categories of Special Dimension Lumber grades. Design values are shown in Tables 2 and 3.

- Structural Decking - 2x4 through 4x12
- Machine Stress-Rated Lumber (MSR) - nominal 2" and less in thickness, 2" and wider

STRUCTURAL DECKING

Grades/End Uses - Standard decking patterns, in nominal 2" single T&G and 3" and 4" double T&G, are available in vee or eased joints to meet most architectural design requirements. For diagrams of available patterns and sizes, order WWPA's *Standard Patterns* (G-16).

While known and used as "roof decking," the load-bearing capacities of structural decking also make it useful as floor decking and solid sidewall construction. **Published design values need to be adjusted for depth effect.** Refer to Tables 2 and H below.

Decking spans are provided in Table 10, page 15.

STRUCTURAL DECKING DESIGN VALUES* Table 2

2" to 4" thick, 4" to 12" wide

USE WITH ADJUSTMENTS, TABLES C, G, H

For Flatwise Use Only

Species	Grade	DRY or MC 15			
		Extreme Fiber Stress in Bending "F _b "		Compression Perpendicular "F _c ⊥"	Modulus of Elasticity "E"
		Single Member	Repetitive Member		
Douglas Fir-Larch	Sel.	1750	2000	625	1,800,000
	Com.	1450	1650	625	1,700,000
Douglas Fir-South	Sel.	1750	1900	520	1,400,000
	Com.	1400	1600	520	1,300,000
Hem-Fir	Sel.	1400	1600	405	1,500,000
	Com.	1150	1350	405	1,400,000
SPFS [§]	Sel.	1150	1350	335	1,400,000
	Com.	950	1100	335	1,200,000
Western Cedars	Sel.	1250	1450	425	1,100,000
	Com.	1050	1200	425	1,000,000
Western Woods	Sel.	1150	1300	335	1,200,000
	Com.	950	1100	335	1,100,000

*Design values in pounds per square inch.

See Table 1 (p. 6) for compression perpendicular-to-grain ($F_{c\perp}$) values.

ADJUSTMENT FACTORS FOR DEPTH EFFECT Table H

For all widths of Structural Decking
 Apply to Dimension Lumber Base Values

Decking bending design values may be adjusted for thickness as shown below because the bending values shown in Table 2 are based on a 4" thick member loaded flatwise.

	NOMINAL THICKNESS		
	2"	3"	4"
	1.10	1.04	1.00

ADJUSTMENTS FOR STRUCTURAL DECKING Checklist 2

- | | |
|--|-----------------|
| <input type="checkbox"/> Duration of Load (C_D) | Table C, page 7 |
| <input type="checkbox"/> Wet Use Factor (C_M)
(only when appropriate) | Table G, page 9 |
| <input type="checkbox"/> Depth Effect | Table H, page 9 |

Framing Lumber

MSR LUMBER

Grades - Machine Stress-Rated Lumber (MSR) is dimension lumber that has been evaluated by mechanical stress-rating equipment. The stress-rating equipment measures the stiffness of the material and sorts it into various Modulus of Elasticity (E) classes. MSR is then subjected to a visual inspection as well.

The grade stamp on MSR lumber indicates that the stress-rating system used meets requirements of the grading agency's certification and quality control procedures. The grade stamp will include the phrase "Machine Rated" along with the E and F_b ratings. The stamp will also include the allowable tensile stress parallel to grain (F_t) and the horizontal shear (F_v) and compression perpendicular to grain ($F_{c\perp}$) design values when any of these properties are specifically qualified. MSR grades are available both in seasoned and unseasoned lumber.

Some MSR lumber producers provide voluntary daily quality control for tension (F_t) in addition to mandatory F_b and E testing. When this additional level of quality control is provided, the F_t value will appear on the grade stamp (in addition to F_b and E).

End Uses - One of the prime uses for Machine Stress-Rated lumber is trusses, however this product is also used as floor and ceiling joists, as rafters and for other structural purposes where assured strength capabilities are primary product considerations.

Code Acceptability - MSR lumber produced under an approved grading agency's certification and quality control procedures is accepted by regulatory agencies and all major building codes.

Refer to page 17 for information on specifying MSR lumber. Order WWPA's *Technical Information Product Sheet, MSR Lumber (TG-4)* for additional information on MSR products and quality control procedures.

MACHINE RATED
 12
 S-DRY 
 1650 Fb 1.5E

Typical MSR Stamp

MACHINE RATED
 12
 S-DRY 
 1650 Fb 1020 Ft 1.5E

MSR Stamp with
Tension Quality Control

MSR LUMBER DESIGN VALUES*

Table 3

2" and less in thickness, 2" and wider

Grades described in Section 52.00 of *Western Lumber Grading Rules*.

Grade Designation ¹	Extreme Fiber Stress in Bending " F_b " ²	Modulus of Elasticity "E"	Tension Parallel-to-Grain " F_t "	Compression Parallel-to-Grain " $F_{c\parallel}$ "
	Single			
2850 Fb-2.3E	2850	2,300,000	2300	2150
2700 Fb-2.2E	2700	2,200,000	2150	2100
2550 Fb-2.1E	2550	2,100,000	2050	2025
2400 Fb-2.0E	2400	2,000,000	1925	1975
2250 Fb-1.9E	2250	1,900,000	1750	1925
2100 Fb-1.8E	2100	1,800,000	1575	1875
1950 Fb-1.7E	1950	1,700,000	1375	1800
1800 Fb-1.6E	1800	1,600,000	1175	1750
1650 Fb-1.5E	1650	1,500,000	1020	1700
1500 Fb-1.4E	1500	1,400,000	900	1650
1450 Fb-1.3E	1450	1,300,000	800	1625
1350 Fb-1.3E	1350	1,300,000	750	1600
1200 Fb-1.2E	1200	1,200,000	600	1400

*Design values in pounds per square inch. Design values for compression perpendicular-to-grain ($F_{c\perp}$) and horizontal shear (F_v) are the same as assigned visually graded lumber of the appropriate species, unless indicated on grade stamp.

¹ For any given value of F_b , the average modulus of elasticity (E) and tension value (F_t) may vary depending upon the species, timber source and other variables. The E and F_t values included in the F_b -E grade designations in the table are those usually associated with each F_b level. Grade stamps may show higher or lower values if machine rating indicates the assignment is appropriate. If the F_t value is different for the MSR grade than that shown in the table for the same F_b level, the assigned F_t value shall be included on the grade stamp. When an E or F_t value varies from the designated F_b level in the table, the tabulated $F_{c\parallel}$, $F_{c\perp}$, and F_v values associated with the designated F_b value are applicable.

² The tabulated F_b values are applicable to lumber loaded on edge. When loaded flatwise, refer to Table E.

ADJUSTMENTS FOR MSR LUMBER

Checklist 3

- Repetitive Member Use Factor (C_r) Table B, page 7
- Duration of Load (C_D) Table C, page 7
- Horizontal Shear (C_H) Table D, page 7
- Flat Use Factor (C_{fu}) Table E, page 9
- Compression Perpendicular ($C_{c\perp}$) Table F, page 9
- Wet Use Factor (C_M) Table G, page 9
(only when appropriate)

Framing Lumber

BEAMS & STRINGERS DESIGN VALUES*

Table 4

5" & thicker, width more than 2" greater than thickness**

Grades Described in Sections 53.00 and 70.00 of *Western Lumber Grading Rules*

Species or Group	Grade	Extreme Fiber Stress in Bending "F _b "**	Tension Parallel-to-Grain "F _t "	Horizontal Shear "F _v "	Compression		Modulus of Elasticity "E"
					Perpendicular "F _c ⊥"	Parallel-to-Grain "F _c //"	
Douglas Fir-Larch	Dense Select Structural	1850	1100	85	730	1300	1,700,000
	Dense No. 1	1550	775	85	730	1100	1,700,000
	Dense No. 2	1000	500	85	730	700	1,400,000
	Select Structural	1600	950	85	625	1100	1,600,000
	No. 1	1350	675	85	625	925	1,600,000
No. 2	875	425	85	625	600	1,300,000	
Douglas Fir-South	Select Structural	1550	900	85	520	1000	1,200,000
	No. 1	1300	625	85	520	850	1,200,000
	No. 2	825	425	85	520	525	1,000,000
Hem-Fir	Select Structural	1250	725	70	405	925	1,300,000
	No. 1	1050	525	70	405	775	1,300,000
	No. 2	675	325	70	405	475	1,100,000
Spruce-Pine-Fir (South)	Select Structural	1050	625	65	335	675	1,200,000
	No. 1	900	450	65	335	575	1,200,000
	No. 2	575	300	65	335	350	1,000,000
Western Cedars	Select Structural	1150	700	70	425	875	1,000,000
	No. 1	975	475	70	425	725	1,000,000
	No. 2	625	325	70	425	475	800,000
Western Woods	Select Structural	1050	625	65	335	675	1,100,000
	No. 1	900	450	65	335	575	1,100,000
	No. 2	575	300	65	335	350	900,000

*Design values in pounds per square inch. See Sections 100.00 through 170.00 in the *Western Lumber Grading Rules* for additional information on these values.

**When the depth of a rectangular sawn lumber bending member exceeds 12 inches, the design value for extreme fiber in bending, F_b, shall be multiplied by the size factor in Table J.

POSTS & TIMBERS DESIGN VALUES*

Table 5

5" x 5" and larger, width not more than 2" greater than thickness**

Grades Described in Sections 53.00 and 80.00 of *Western Lumber Grading Rules*

Species or Group	Grade	Extreme Fiber Stress in Bending "F _b "**	Tension Parallel-to-Grain "F _t "	Horizontal Shear "F _v "	Compression		Modulus of Elasticity "E"
					Perpendicular "F _c ⊥"	Parallel-to-Grain "F _c //"	
Douglas Fir-Larch	Dense Select Structural	1750	1150	85	730	1350	1,700,000
	Dense No. 1	1400	950	85	730	1200	1,700,000
	Dense No. 2	800	550	85	730	550	1,400,000
	Select Structural	1500	1000	85	625	1150	1,600,000
	No. 1	1200	825	85	625	1000	1,600,000
	No. 2	700	475	85	625	475	1,300,000
Douglas Fir-South	Select Structural	1400	950	85	520	1050	1,200,000
	No. 1	1150	775	85	520	925	1,200,000
	No. 2	650	400	85	520	425	1,000,000
Hem-Fir	Select Structural	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
Spruce-Pine-Fir (South)	Select Structural	1000	675	65	335	700	1,200,000
	No. 1	800	550	65	335	625	1,200,000
	No. 2	350	225	65	335	225	1,000,000
Western Cedars	Select Structural	1100	720	70	425	925	1,000,000
	No. 1	875	600	70	425	800	1,000,000
	No. 2	500	350	70	425	375	800,000
Western Woods	Select Structural	1000	675	65	335	700	1,100,000
	No. 1	800	550	65	335	625	1,100,000
	No. 2	350	225	65	335	225	900,000

*Design values in pounds per square inch. See Sections 100.00 through 170.00 in the *Western Lumber Grading Rules* for additional information on these values.

**When the depth on a rectangular sawn lumber bending member exceeds 12 inches, the design value for extreme fiber in bending, F_b, shall be multiplied by the size factor in Table J.

Framing Lumber

TIMBERS

Grades/End Uses - "Timbers" is both a general classification for the larger sizes of structural framing lumber and the name of a specific grade and size. There are two basic grade groups within this "Timbers" classification:

- Beams and Stringers - 5" and thicker, width more than 2" greater than thickness (6x10, 8x12, etc.)
- Post and Timbers - 5x5 and larger, width not more than 2" greater than thickness (6x6, 6x8, etc.)

Design values assigned to each grade and species group are shown in Tables 4 and 5, page 11. End uses include heavy framing applications in both conventional and pre-engineered systems. This classification of grades requires its own Wet Use Adjustment, Table I and Size/Depth Effect Adjustment, Table J (see below).

ADJUSTMENT FACTORS FOR TIMBERS

WET USE FACTOR (C_M) Table I **APPLY TO BEAMS & STRINGERS/ POSTS & TIMBERS** 5" and thicker lumber

When lumber 5" and thicker is designed for exposed uses where the moisture content will exceed 19% for an extended period of time, the design values shown in Tables 4 and 5 should be multiplied by the following adjustment factors:

F_b	F_t	F_v	$F_{c\perp}$	F_c	E
1.00	1.00	1.00	0.67	0.91	1.00

SIZE/DEPTH EFFECT ADJUSTMENT (C_F) Table J **APPLY TO BEAMS & STRINGERS/ POSTS & TIMBERS** 5" and thicker lumber

When the depth of a rectangular sawn lumber bending member exceeds 12 inches, the design value for extreme fiber stress in bending (F_b) shall be multiplied by the size factor C_F , as determined by this formula:

$$C_F = \left(\frac{12}{d}\right)^{1/9}$$

Note: The following adjustment factors are derived from the formula above.

Nominal Depth	Net Surfaced Depth (d)	Depth Adjustment Factor (C_F)
14	13.5	0.987
16	15.5	0.972
18	17.5	0.959
20	19.5	0.947
22	21.5	0.937
24	23.5	0.928
26	25.5	0.920
28	27.5	0.912
30	29.5	0.905

ADJUSTMENTS FOR BEAMS & STRINGERS/ POSTS & TIMBERS Checklist 4

- | | |
|---|------------------|
| <input type="checkbox"/> Duration of Load (C_D) | Table C, page 7 |
| <input type="checkbox"/> Horizontal Shear (C_H) | Table D, page 7 |
| <input type="checkbox"/> Compression Perpendicular ($C_{C\perp}$) | Table F, page 9 |
| <input type="checkbox"/> Wet Use Adjustment (C_M) | Table I, page 12 |
| <input type="checkbox"/> Depth Effect | Table J, page 12 |

PHYSICAL PROPERTIES ILLUSTRATED

Extreme Fiber Stress in Bending - F_b (fig. 1). When loads are applied, structural members bend, producing tension in the fibers along the faces farthest from the applied load and compression in the fibers along the face nearest to the applied load. These induced stresses in the fibers are designated as "extreme fiber stress in bending" (F_b).

Single Member F_b design values are used in design where the strength of an individual piece, such as a beam, may be solely responsible for carrying a specific design load.

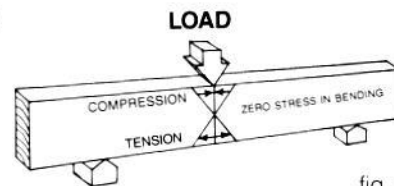


fig. 1

Repetitive Member F_b design values are used in design when three or more load sharing members, such as joists, rafters, or studs, are spaced no more than 24" apart and are joined by flooring, sheathing or other load distributing elements. Repetitive members are also used where pieces are adjacent, such as decking.

Fiber Stress in Tension - F_t (fig. 2). Tensile stresses are similar to compression parallel-to-grain in that they act across the full cross section and tend to stretch the piece. Length does not affect tensile stresses.

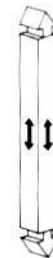


fig. 2

Horizontal Shear - F_v (fig. 3). Horizontal shear stresses tend to slide fibers over each other horizontally. Most predominate in short, heavily loaded deep beams. Increasing beam cross section decreases shear stresses.

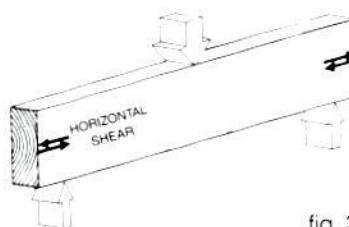


fig. 3

Framing Lumber

Compression Perpendicular-to-Grain - $F_{c\perp}$ (fig. 4).

Where a joist, beam or similar piece of lumber bears on supports, the loads tend to compress the fibers. It is therefore necessary that the bearing area is sufficient to prevent side grain crushing.

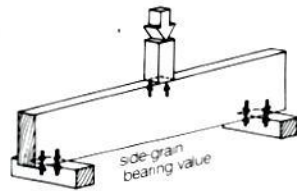


fig. 4

Compression Parallel-to-Grain - $F_{c\parallel}$ (fig. 5).

In many parts of a structure, stress grades are used where the loads are supported on the ends of the pieces. Such uses are as studs, posts, columns and struts. The internal stress induced by this kind of loading is the same across the whole cross-section and the fibers are uniformly stressed parallel to and along the full length of the piece.

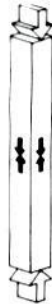


fig. 5

Modulus of Elasticity - E (fig. 6). The modulus of elasticity (E) is a ratio of the amount a material will deflect in proportion to an applied load.

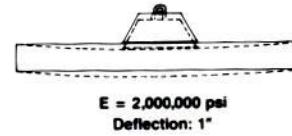
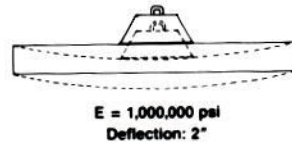


fig. 6

STANDARD SIZES-FRAMING LUMBER

Nominal & Dressed

Based on Western Lumber Grading Rules

Table 6

Product	Description	Nominal Size		Dressed Dimensions		Length (feet)	
		Thickness (inches)	Width (inches)	Thicknesses & Widths (inches)			
				Surfaced Dry	Surfaced Unseasoned		
DIMENSION	S4S	2	2	1 1/2	1 9/16	6' and longer, generally shipped in multiples of 2'	
		3	3	2 1/2	2 9/16		
		4	4	3 1/2	3 9/16		
			5	4 1/2	4 5/8		
			6	5 1/2	5 5/8		
			8	7 1/4	7 1/2		
			10	9 1/4	9 1/2		
			12	11 1/4	11 1/2		
	over 12		off 3/4	off 1/2			
TIMBERS	Rough or S4S (shipped unseasoned)	5 and larger		Thickness (unseasoned) 1/2 off nominal (S4S). See 3.20 of WPA Grading Rules for Rough.	Width (unseasoned)	6' and longer, generally shipped in multiples of 2'	
DECKING	2" (Single T&G)		Thickness	Width	Thickness (Dry)	Face Width (Dry)	6' and longer, generally shipped in multiples of 2'
			2	5	1 1/2	4	
				6		5	
				8		6 3/4	
				10		8 3/4	
		12		10 3/4			
	3" and 4" (Double T&G)	3	6	2 1/2	5 1/4		
		4		3 1/2			

Abbreviations:

FOHC - Free of Heart Center
S4S - Surfaced four sides.

T&G - Tongued and grooved.

Rough Full Sawn - Unsurfaced lumber cut to full specified size.

Framing Lumber

FLOOR JOIST SPANS

40# Live Load
10# Dead Load

Table 7

L/360

Design Criteria: Strength - 10 lbs per sq. ft. dead load plus 40 lbs. per sq. ft. live load.
Deflection - Limited in span in inches divided by 360 for live load only.

Species or Group	Grade*	Span (feet and inches)											
		2 x 6			2 x 8			2 x 10			2 x 12		
		12" oc	16" oc	24" oc	12" oc	16" oc	24" oc	12" oc	16" oc	24" oc	12" oc	16" oc	24" oc
Douglas Fir-Larch	1 & Btr	11-2	10-2	8-10	14-8	13-4	11-8	18-9	17-0	14-5	22-10	20-5	16-8
	1	10-11	9-11	8-8	14-5	13-1	11-0	18-5	16-5	13-5	22-0	19-1	15-7
	2	10-9	9-9	8-1	14-2	12-7	10-3	17-9	15-5	12-7	20-7	17-10	14-7
	3	8-8	7-6	6-2	11-0	9-6	7-9	13-5	11-8	9-6	15-7	13-6	11-0
Douglas Fir-South	1	10-0	9-1	7-11	13-2	12-0	10-5	16-10	15-3	12-9	20-6	18-1	14-9
	2	9-9	8-10	7-9	12-10	11-8	10-0	16-5	14-11	12-2	19-11	17-4	14-2
	3	8-6	7-4	6-0	10-9	9-3	7-7	13-1	11-4	9-3	15-2	13-2	10-9
Hem-Fir	1 & Btr	10-6	9-6	8-3	13-10	12-7	11-0	17-8	16-0	13-9	21-6	19-6	16-0
	1	10-6	9-6	8-3	13-10	12-7	10-9	17-8	16-0	13-1	21-6	18-7	15-2
	2	10-0	9-1	7-11	13-2	12-0	10-2	16-10	15-2	12-5	20-4	17-7	14-4
	3	8-8	7-6	6-2	11-0	9-6	7-9	13-5	11-8	9-6	15-7	13-6	11-0
Spruce-Pine-Fir (South)	1	9-9	8-10	7-8	12-10	11-8	10-2	16-5	14-11	12-5	19-11	17-7	14-4
	2	9-6	8-7	7-6	12-6	11-4	9-6	15-11	14-3	11-8	19-1	16-6	13-6
	3	8-0	6-11	5-8	10-2	8-9	7-2	12-5	10-9	8-9	14-4	12-5	10-2
Western Woods	1	9-6	8-7	7-0	12-6	10-10	8-10	15-4	13-3	10-10	17-9	15-5	12-7
	2	9-2	8-4	7-0	12-1	10-10	8-10	15-4	13-3	10-10	17-9	15-5	12-7
	3	7-6	6-6	5-4	9-6	8-3	6-9	11-8	10-1	8-3	13-6	11-8	9-6

*Spans were computed for commonly marketed grades and species. Spans for other grades and Western Cedars can be computed using the WWPA Span Computer.

FLOOR JOIST SPANS

30# Live Load (limited to sleeping areas)
10# Dead Load

Table 8

L/360

Design Criteria: Strength - 10 lbs per sq. ft. dead load plus 30 lbs. per sq. ft. live load.
Deflection - Limited to span in inches divided by 360 for live load only.

Species or Group	Grade*	Span (feet and inches)											
		2 x 6			2 x 8			2 x 10			2 x 12		
		12" oc	16" oc	24" oc	12" oc	16" oc	24" oc	12" oc	16" oc	24" oc	12" oc	16" oc	24" oc
Douglas Fir-Larch	1 & Btr	12-3	11-2	9-9	16-2	14-8	12-10	20-8	18-9	16-1	25-1	22-10	18-8
	1	12-0	10-11	9-7	15-10	14-5	12-4	20-3	18-5	15-0	24-8	21-4	17-5
	2	11-10	10-9	9-1	15-7	14-1	11-6	19-10	17-2	14-1	23-0	19-11	16-3
	3	9-8	8-5	6-10	12-4	10-8	8-8	15-0	13-0	10-7	17-5	15-1	12-4
Douglas Fir-South	1	11-0	10-0	8-9	14-6	13-2	11-6	18-6	16-10	14-3	22-6	20-3	16-6
	2	10-9	9-9	8-6	14-2	12-10	11-2	18-0	16-5	13-8	21-11	19-4	15-10
	3	9-6	8-2	6-8	12-0	10-5	8-6	14-8	12-8	10-4	17-0	14-8	12-0
Hem-Fir	1 & Btr	11-7	10-6	9-2	15-3	13-10	12-1	19-5	17-8	15-5	23-7	21-6	17-10
	1	11-7	10-6	9-2	15-3	13-10	12-0	19-5	17-8	14-8	23-7	20-9	17-0
	2	11-0	10-0	8-9	14-6	13-2	11-4	18-6	16-10	13-10	22-6	19-8	16-1
	3	9-8	8-5	6-10	12-4	10-8	8-8	15-0	13-0	10-7	17-5	15-1	12-4
Spruce-Pine-Fir (South)	1	10-9	9-9	8-6	14-2	12-10	11-3	18-0	16-5	13-10	21-11	19-8	16-1
	2	10-5	9-6	8-3	13-9	12-6	10-8	17-6	15-11	13-0	21-4	18-6	15-1
	3	8-11	7-9	6-4	11-4	9-10	8-0	13-10	12-0	9-9	16-1	13-11	11-4
Western Woods	1	10-5	9-6	7-10	13-9	12-2	9-11	17-1	14-10	12-1	19-10	17-2	14-0
	2	10-1	9-2	7-10	13-4	12-1	9-11	17-0	14-10	12-1	19-10	17-2	14-0
	3	8-5	7-3	5-11	10-8	9-3	7-6	13-0	11-3	9-2	15-1	13-1	10-8

*Spans were computed for commonly marketed grades and species. Spans for other grades and Western Cedars can be computed using the WWPA Span Computer.

Refer to WWPA's WESTERN LUMBER SPAN TABLES (#572) for 72 additional span tables and load conditions.

Framing Lumber

CEILING JOIST SPANS

20# Live Load (limited attic storage)
10# Dead Load

Design Criteria: Strength - 10 lbs per sq. ft. dead load plus 20 lbs. per sq. ft. limited storage.
Deflection - Limited in span in inches divided by 240 for live load only.

Table 9

L/240

Species or Group	Grade*	Span (feet and inches)											
		2 x 6			2 x 8			2 x 10			2 x 12		
		12" oc	16" oc	24" oc	12" oc	16" oc	24" oc	12" oc	16" oc	24" oc	12" oc	16" oc	24" oc
Douglas Fir-Larch	1 & Btr	16-1	14-7	12-0	21-2	18-8	15-3	26-4	22-9	18-7	30-6	26-5	21-7
	1	15-9	13-9	11-2	20-1	17-5	14-2	24-6	21-3	17-4	28-5	24-8	20-1
	2	14-10	12-10	10-6	18-9	16-3	13-3	22-11	19-10	16-3	26-7	23-0	18-10
	3	11-2	9-8	7-11	14-2	12-4	10-0	17-4	15-0	12-3	20-1	17-5	14-3
Douglas Fir-South	1	14-5	13-0	10-8	19-0	16-6	13-6	23-3	20-2	16-5	27-0	23-4	19-1
	2	14-1	12-6	10-2	18-3	15-9	12-11	22-3	19-3	15-9	25-10	22-4	18-3
	3	10-11	9-6	7-9	13-10	12-0	9-9	16-11	14-8	11-11	19-7	17-0	13-10
Hem-Fir	1 & Btr	15-2	13-9	11-6	19-11	17-10	14-7	25-2	21-9	17-9	29-2	25-3	20-7
	1	15-2	13-5	10-11	19-7	16-11	13-10	23-11	20-8	16-11	27-9	24-0	19-7
	2	14-5	12-8	10-4	18-6	16-0	13-1	22-7	19-7	16-0	26-3	22-8	18-6
	3	11-2	9-8	7-11	14-2	12-4	10-0	17-4	15-0	12-3	20-1	17-5	14-3
Spruce-Pine-Fir (South)	1	14-1	12-8	10-4	18-6	16-0	13-1	22-7	19-7	16-0	26-3	22-8	18-6
	2	13-8	11-11	9-8	17-5	15-1	12-4	21-3	18-5	15-0	24-8	21-4	17-5
	3	10-4	8-11	7-4	13-1	11-4	9-3	16-0	13-10	11-4	18-6	16-1	13-1
Western Woods	1	12-9	11-1	9-0	16-2	14-0	11-5	19-9	17-1	14-0	22-11	19-10	16-3
	2	12-9	11-1	9-0	16-2	14-0	11-5	19-9	17-1	14-0	22-11	19-10	16-3
	3	9-8	8-5	6-10	12-4	10-8	8-8	15-0	13-0	10-7	17-5	15-1	12-4

*Spans were computed for commonly marketed grades and species. Spans for other grades and Western Cedars can be computed using the WWPA Span Computer.

STRUCTURAL DECKING SPANS

Spans for 4" to 12" wide lumber manufactured and used at a maximum moisture content of 19%.
Spans are given in feet-inches.

Table 10

SPECIES	2" Thick Decking												3" Thick Decking											
	Douglas Fir-Larch		Douglas Fir-South		Hem-Fir		Spruce-Pine-Fir (South)		Western Cedars		Western Woods		Douglas Fir-Larch		Douglas Fir-South		Hem-Fir		Spruce-Pine-Fir (South)		Western Cedars		Western Woods	
	Select	Comm	Select	Comm	Select	Comm	Select	Comm	Select	Comm	Select	Comm	Select	Comm	Select	Comm	Select	Comm	Select	Comm	Select	Comm	Select	Comm
FLOOR DECKING — 10 psf Dead Load / 40 psf Live Load (normal load)																								
L/480 Deflection Limit																								
Simple	5-6	5-5	5-1	4-11	5-2	5-1	5-1	4-10	4-8	4-7	4-10	4-8	9-3	9-0	8-6	8-3	8-8	8-6	8-6	8-1	7-10	7-7	8-1	7-10
Controlled	6-0	5-11	5-7	5-5	5-8	5-7	5-7	5-3	5-1	5-0	5-3	5-1	10-7	10-4	9-9	9-6	9-11	9-9	9-9	9-3	9-0	8-8	9-3	9-0
ROOF DECKING — 10 psf Dead Load / 20 psf Live Load (seven-day load)																								
L/240 Deflection Limit																								
Simple	8-9	8-7	8-1	7-10	8-3	8-1	8-1	7-8	7-5	7-3	7-8	7-5	14-7	14-4	13-5	13-1	13-9	13-5	13-5	12-9	12-5	12-0	12-9	12-5
Controlled	9-7	9-5	8-10	8-7	9-0	8-10	8-10	8-4	8-2	7-10	8-4	8-2	16-9	16-5	15-5	15-1	15-9	15-5	15-5	14-8	14-3	13-9	14-8	14-3
ROOF DECKING — 10 psf Dead Load / 30 psf Live Load (snow load)																								
L/240 Deflection Limit																								
Simple	7-8	7-6	7-1	6-11	7-3	7-1	7-1	6-8	6-6	6-4	6-8	6-6	12-9	12-6	11-9	11-6	12-0	11-9	11-9	11-2	10-10	10-6	11-2	10-10
Controlled	8-4	8-3	7-8	7-6	7-10	7-8	7-8	7-4	7-1	6-11	7-4	7-1	14-8	14-5	13-6	13-2	13-9	13-6	13-6	12-10	12-5	12-1	12-10	12-5
ROOF DECKING — 10 psf Dead Load / 40 psf Live Load (snow load)																								
L/240 Deflection Limit																								
Simple	7-0	6-10	6-5	6-3	6-7	6-5	6-5	6-1	5-11	5-9	6-1	5-11	11-7	11-5	10-8	10-5	10-11	10-8	10-8	10-2	9-10	9-6	10-2	9-10
Controlled	7-7	7-6	7-0	6-10	7-2	7-0	7-0	6-8	6-5	6-3	6-8	6-5	13-4	13-1	12-3	11-11	12-6	12-3	12-3	11-8	11-4	10-11	11-8	11-4

Spans for Dimension Lumber (8" and narrower) run-to-pattern as 2" and 3" decking may be used as follows:

No. 2 Grade

DF-L uses spans for Hem-Fir Selected Decking.
DF-S uses spans for Western Woods Selected Decking.
H-F uses spans for Douglas Fir-South Commercial Decking.
SPFS uses spans for Western Woods Commercial Decking.
Other species groups use spans for Western Cedars Commercial Decking.

No. 3 Grade (for Roof Decking: use Simple Lay-up spans for both Simple and Controlled Random Lay-ups)

DF-L uses spans for Douglas Fir-South Selected Decking.
DF-S uses spans for Western Cedars Selected Decking.
H-F uses spans for Western Woods Selected Decking.
SPFS uses spans for Western Cedars Commercial Decking.
Other species groups use spans for Western Cedars Commercial Decking with reductions of 3" for 2" Decking, and 5" for 3" Decking.

Framing Lumber

PROPERTIES OF STANDARD DRESSED SIZES (S4S)

Certain mathematical expressions of the properties or elements of sections are used in computing the values of structural members of various shapes for the various conditions under which they are subjected to stress. The properties or elements of sections of standard sizes of joists, planks, beams, stringers, posts, timbers and decking are given in the following tables.

NEUTRAL AXIS, X-X in the diagrams, in the cross section of a beam or column in a state of flexure, is the line on which there is neither tension nor compression.

In the following tables, which show the properties of the rectangular and square sections of lumber, the neutral axis has been assumed as perpendicular to the depth of the section at its center, the depth "h" being parallel to and in the direction of the application of the force or load.

MOMENT OF INERTIA, I, of the cross section of a beam is the sum of the products of each of its elementary areas by the square of their distance from the neutral axis of the section.

SECTION MODULUS, S, is the moment of inertia divided by the distance from the neutral axis to extreme fiber of the section.

CROSS SECTION is a section taken through the member perpendicular to its longitudinal axis.

SECTION PROPERTIES PLANKS

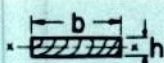


Table 11

Nominal Size Inches b h	Surfaced Size Inches For Design b h	Area (A) A = bh (In ²)	Section Modulus (S) $S = \frac{bh^2}{6}$ (In ³)	Moment of Inertia (I) $I = \frac{bh^3}{12}$ (In ⁴)	Board Feet Per Linear Foot of Piece
3 x 2	2.5 x 1.5	3.75	0.938	0.703	0.50
4 x 2	3.5 x 1.5	5.25	1.312	0.984	0.67
5 x 2	4.5 x 1.5	6.75	1.688	1.266	0.83
6 x 2	5.5 x 1.5	8.25	2.062	1.547	1.00
8 x 2	7.25 x 1.5	10.88	2.719	2.039	1.33
10 x 2	9.25 x 1.5	13.88	3.469	2.602	1.67
12 x 2	11.25 x 1.5	16.88	4.219	3.164	2.00
4 x 3	3.5 x 2.5	8.75	3.646	4.557	1.00
5 x 3	4.5 x 2.5	11.25	4.688	5.859	1.25
6 x 3	5.5 x 2.5	13.75	5.729	7.161	1.50
8 x 3	7.25 x 2.5	18.12	7.552	9.440	2.00
10 x 3	9.25 x 2.5	23.12	9.635	12.044	2.50
12 x 3	11.25 x 2.5	28.12	11.719	14.648	3.00
14 x 3	13.25 x 2.5	33.12	13.802	17.253	3.50
16 x 3	15.25 x 2.5	38.12	15.885	19.857	4.00
5 x 4	4.5 x 3.5	15.75	9.188	16.078	1.67
6 x 4	5.5 x 3.5	19.25	11.229	19.651	2.00
8 x 4	7.25 x 3.5	25.38	14.802	25.904	2.67
10 x 4	9.25 x 3.5	32.38	18.885	33.049	3.33
12 x 4	11.25 x 3.5	39.38	22.969	40.195	4.00
14 x 4	13.25 x 3.5	46.38	27.052	47.341	4.67
16 x 4	15.25 x 3.5	53.38	31.135	54.487	5.33

SECTION PROPERTIES JOISTS AND BEAMS



Table 12

Nominal Size Inches b h	Surfaced Size Inches For Design b h	Area (A) A = bh (In ²)	Section Modulus (S) $S = \frac{bh^2}{6}$ (In ³)	Moment of Inertia (I) $I = \frac{bh^3}{12}$ (In ⁴)	Board Feet Per Linear Foot of Piece
2 x 2	1.5 x 1.5	2.25	0.562	0.422	0.33
2 x 3	1.5 x 2.5	3.75	1.56	1.95	0.50
2 x 4	1.5 x 3.5	5.25	3.06	5.36	0.67
2 x 5	1.5 x 4.5	6.75	5.06	11.39	.83
2 x 6	1.5 x 5.5	8.25	7.56	20.80	1.00
2 x 8	1.5 x 7.25	10.88	13.14	47.63	1.33
2 x 10	1.5 x 9.25	13.88	21.39	98.93	1.67
2 x 12	1.5 x 11.25	16.88	31.64	177.98	2.00
2 x 14	1.5 x 13.25	19.88	43.89	290.78	2.33
3 x 3	2.5 x 2.5	6.25	2.60	3.26	0.75
3 x 4	2.5 x 3.5	8.75	5.10	8.93	1.00
3 x 5	2.5 x 4.5	11.25	8.44	18.98	1.25
3 x 6	2.5 x 5.5	13.75	12.60	34.66	1.50
3 x 8	2.5 x 7.25	18.12	21.90	79.39	2.00
3 x 10	2.5 x 9.25	23.12	35.65	164.89	2.50
3 x 12	2.5 x 11.25	28.12	52.73	296.63	3.00
3 x 14	2.5 x 13.25	33.12	73.15	484.63	3.50
3 x 16	2.5 x 15.25	38.12	96.90	738.87	4.00
4 x 4	3.5 x 3.5	12.25	7.15	12.51	1.33
4 x 5	3.5 x 4.5	15.75	11.81	26.58	1.67
4 x 6	3.5 x 5.5	19.25	17.65	48.53	2.00
4 x 8	3.5 x 7.25	25.38	30.66	111.15	2.67
4 x 10	3.5 x 9.25	32.38	49.91	230.84	3.33
4 x 12	3.5 x 11.25	39.38	73.83	415.28	4.00
4 x 14	3.5 x 13.25	46.38	102.41	678.48	4.67
4 x 16	3.5 x 15.25	53.38	135.66	1034.42	5.33
6 x 6	5.5 x 5.5	30.25	27.73	76.26	3.00
6 x 8	5.5 x 7.5	41.25	51.56	193.36	4.00
6 x 10	5.5 x 9.5	52.25	82.73	392.96	5.00
6 x 12	5.5 x 11.5	63.25	121.23	697.07	6.00
6 x 14	5.5 x 13.5	74.25	167.06	1127.67	7.00
6 x 16	5.5 x 15.5	85.25	220.23	1706.78	8.00
6 x 18	5.5 x 17.5	96.25	280.73	2456.38	9.00
6 x 20	5.5 x 19.5	107.25	348.56	3398.48	10.00
8 x 8	7.5 x 7.5	56.25	70.31	263.67	5.33
8 x 10	7.5 x 9.5	71.25	112.81	535.86	6.67
8 x 12	7.5 x 11.5	86.25	165.31	950.55	8.00
8 x 14	7.5 x 13.5	101.25	227.81	1537.73	9.33
8 x 16	7.5 x 15.5	116.25	300.31	2327.42	10.67
8 x 18	7.5 x 17.5	131.25	382.81	3349.61	12.00
8 x 20	7.5 x 19.5	146.25	475.31	4634.30	13.33
8 x 22	7.5 x 21.5	161.25	577.81	6211.48	14.67
8 x 24	7.5 x 23.5	176.25	690.31	8111.17	16.00
10 x 10	9.5 x 9.5	90.25	142.90	678.76	8.33
10 x 12	9.5 x 11.5	109.25	209.40	1204.03	10.00
10 x 14	9.5 x 13.5	128.25	288.56	1947.80	11.67
10 x 16	9.5 x 15.5	147.25	380.40	2948.07	13.33
10 x 18	9.5 x 17.5	166.25	484.90	4242.84	15.00
10 x 20	9.5 x 19.5	185.25	602.06	5870.11	16.67
10 x 22	9.5 x 21.5	204.25	731.90	7867.88	18.33
12 x 12	11.5 x 11.5	132.25	253.48	1457.51	12.00
12 x 14	11.5 x 13.5	155.25	349.31	2357.86	14.00
12 x 16	11.5 x 15.5	178.25	460.48	3568.71	16.00
12 x 18	11.5 x 17.5	201.25	586.98	5136.07	18.00
12 x 20	11.5 x 19.5	224.25	728.81	7105.92	20.00
12 x 22	11.5 x 21.5	247.25	885.98	9524.28	22.00
12 x 24	11.5 x 23.5	270.25	1058.48	12437.13	24.00

SECTION PROPERTIES DECKING (per foot width)

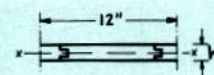


Table 13

Nominal Size Inches h	Surfaced Size Inches For Design b h	Area (A) A = bh (In ²)	Section Modulus (S) $S = \frac{bh^2}{6}$ (In ³)	Moment of Inertia (I) $I = \frac{bh^3}{12}$ (In ⁴)
2	12 x 1.5	18.00	4.50	3.375
3	12 x 2.5	30.00	30.00	15.625
4	12 x 3.5	42.00	24.50	42.875

Framing Lumber

SPECIFYING ROUGH CARPENTRY MATERIALS

All lumber should be gradestamped by an agency certified by the Board of Review of the American Lumber Standard Committee and manufactured in accordance with *Product Standard PS 20-94*, as published by the Department of Commerce.

The following guidelines are intended to assist the designer and specifier in establishing the most economical and efficient use of solid lumber products and to eliminate potential misunderstandings between specifier and supplier.

A specification should include all species suited to the job. This broadens availability which can lower costs. Specify standard grades as described in the official WWA *Western Lumber Grading Rules*. Consider all grades suitable for the intended use. For economy in construction, it is recommended that the lowest grade suited to a job be specified.

Verify availability of species and grades with local suppliers. Not all species, grades or patterns are available in all locations.

Structural design values vary depending on size, grade and species. Values assigned to lumber 2" to 4" in thickness are assigned to the dry size. Unseasoned lumber is manufactured oversized so that when it reaches 19% moisture content it will be approximately the same size as the dry (S-DRY or KD) size*. Therefore, when unseasoned (S-GRN) lumber is shipped, the same design values that are assigned and used for dry lumber will apply. Design values assigned to lumber 5" x 5" and larger are assigned to the unseasoned (S-GRN) green size.

2" to 4" thick by 2" to 4" wide Framing Lumber - The most widely available grades are STANDARD & BETTER (STAND & BTR) and STUD, in all of the commercial softwood species.

These grades are appropriate for most general wall framing applications.

STUD, STAND & BTR and the other grades (CONSTRUCTION and UTILITY) are available in any conventional length. Dimension Lumber grades apply to both solid sawn and certified structural glued lumber.

UTILITY, in any commercial softwood species, may be used for plates, blocking, etc. and some walls. Review building codes for acceptance.

When small posts or beams (2x4, 4x4) require specific design values, refer to Table 1 to determine appropriateness of CONSTRUCTION, STANDARD and UTILITY grades. Specify according to BASE VALUES. Specified BASE VALUES are then modified by adjustments for engineering analysis.

Some 2x2s through 4x4s may require higher design values than available in these grades. In this case, refer to Table 1 in SELECT STRUCTURAL, NO. 1 & BTR, NO. 1, NO. 2 and NO. 3 grades. Specify BASE VALUE structural values. Adjust BASE VALUES from Table 1 for engineering analysis. Or refer to the design values for Machine Stress-Rated Lumber in Table 3.

Specifying Machine Stress-Rated Lumber is very straightforward because it is generally marketed by strength and stiffness values, F_b and E .

*Note: S-DRY (or KD) and S-GRN lumber should not be mixed in a horizontal framing system, e.g. floor joists. While both are of the same strength and both will eventually reach the same size, the two will acclimate at different rates before achieving equilibrium with the atmosphere.

When ordering, specify machine-rated, gradestamped lumber and list the strength value (F_b) and corresponding modulus of elasticity (E) values, nominal sizes and lengths required. Species should only be specified when horizontal shear (F_v), compression perpendicular-to-grain ($F_{c\perp}$) or specific gravity are controlling.

Some MSR lumber producers provide voluntary daily quality control for tension (F_t) in addition to the mandatory F_b and E testing. When this additional level of quality control is provided, the F_t value will appear on the gradestamp (in addition to F_b and E).

2" to 4" thick by 5" and wider Framing Lumber -

Joists, rafters and small beams should be specified by minimum required F_b and E BASE VALUES. Refer to Table 1, page 6, with Adjustment Factors. Whenever possible, design values should be based on NO. 2 grade values of locally available species as most material is marketed NO. 2 & BETTER. NO. 1 & BTR J&P may be available in some markets in some species. Higher values should only be used for longer spans or higher loads. Lightly loaded structures should take advantage of the economy of NO. 3 grade. Machine stress-rated and certified structural glued material of some stresses can be used interchangeably with the above.

Where engineering analysis permits, 2x6 studs can be NO. 3 or STUD grade.

5x5 and larger, Beams/Stringers and Posts/Timbers -

The grades are SELECT STRUCTURAL, NO. 1 or NO. 2. Grade and species should be determined by required design values. Refer to Tables 4 & 5, page 11, with appropriate adjustments for conditions of use. Where a maximum dimensional stability is a requirement, specify Free of Heart Center (FOHC), realizing costs will be increased and availability limited.

Structural Decking - The grades are SELECTED DECKING and COMMERCIAL DECKING. Decking is manufactured either at 19% (S-DRY or KD) or 15% (MC-15 or KD-15) moisture content. Decking should be allowed to acclimate to its surrounding atmosphere prior to installation. Refer to "Seasoning..." on page 20. Edge gluing is not generally recommended. MC-15 or KD-15 will minimize shrinkage for exposed applications and may be available at an increased cost. Check with local suppliers.

Some tongued-and-grooved is manufactured to pattern from NO. 2 & BETTER or NO. 3, 2x6 or 2x8 framing lumber, and is generally used for concealed subfloors in deck and girder construction. Refer to Table H, page 9, for Depth Effect increase for Decking grades. (Table E, page 9, is for Base Value Dimension grades.)

Appearance of Framing Material - Where structural material is to receive a natural finish and appearance is a factor, the top grade in the respective size category may be specified. While such a specification may yield structural products of good appearance, it is important to recognize that structural grades of lumber are graded primarily for strength rather than appearance and even in the highest grades visual imperfections are not eliminated. The added expense and limited availability of the visually perfect structural grades should be evaluated. If limited quantities are required it may be beneficial to specify hand-selected material, rather than the top grade, dictating which visual characteristics are unacceptable.

Appearance Lumber

INTRODUCTION

The lumber grades in this category are intended for applications where strength is not the primary consideration. Grading is by visual inspection and is a judgment of appearance and suitability to end use rather than of strength. Natural characteristics and manufacturing imperfections are taken into account in the assigning of grades. Lumber in this category is often generically referred to as Board Lumber, although the category also includes run-to-pattern products and Patio Decking. The highest grades of Appearance Lumber are seldom gradestamped, unless on the back or ends, as the grade stamp would deface the product. The general purpose grades, such as COMMONS and ALTERNATE BOARDS, are generally stamped. Refer to page 20 for additional information on grade stamps, moisture content and specifying Appearance Lumber.

Many of the Western Lumber species are grown, harvested, manufactured and shipped together in "Marketing Categories". In addition to the species combinations that share like structural characteristics, Board Lumber is often available in combinations related to like appearance characteristics. Refer to the Marketing Categories species list on page 4 and the WWPA *Western Lumber Grading Rules* for additional information.

The grades and recommended end uses for Appearance Lumber are explained in Table 14. Standard sizes are explained in Table 15. Refer to page 19 for information on the Radius-edged Patio Decking grades.

APPEARANCE LUMBER GRADES Table 14

	Product	Grades ¹	Equivalent Grades in Idaho White Pine	WWPA Grading Rules Section Number
Highest Quality Appearance Grades	SELECTS <i>(all species)</i>	B & Btr Select	Supreme	10.11
		C Select	Choice	10.12
		D Select	Quality	10.13
	FINISH <i>(usually available only in Doug Fir and Hem-Fir)</i>	Superior		10.51
		Prime		10.52
		E		10.53
	SPECIAL WESTERN RED CEDAR PATTERN ² GRADES	Clear Heart		20.11
		A Grade		20.12
		B Grade		20.13
	General Purpose Grades	COMMON BOARDS <i>(WWPA Rules)</i> <i>(primarily in pines, spruces and cedars)</i>	1 Common	Colonial
2 Common			Sterling	30.12
3 Common			Standard	30.13
4 Common			Utility	30.14
5 Common			Industrial	30.15
ALTERNATE BOARDS <i>(WCLIB Rules)</i> <i>(primarily in Doug Fir and Hem-Fir)</i>		Select Merchantable		WCLIB 118-a
		Construction		118-b
		Standard		118-c
		Utility		118-d
		Economy		118-e
SPECIAL WESTERN RED CEDAR PATTERN ² GRADES	Select Knotty		WCLIB 111-e	
	Quality Knotty		111-f	

¹ Refer to WWPA's Vol. 2, *Western Wood Species* book (#11) for full-color photographs and to WWPA's *Natural Wood Siding* (TG-8) for complete information on siding grades, specification and installation.

² "Pattern" includes Finish, Paneling, Ceiling and Siding grades.

BOARD LUMBER

Grades/End Uses - Select grades are determined from the better side or face and are used for applications where only the finest appearance is appropriate. B & BTR is virtually clear, and very limited in availability. C and D SELECTS are only slightly less perfect.

Finish grades are determined from the better side or face and from both edges on pieces 5" and narrower and from the better side or face and edge on pieces 6" and wider. SUPERIOR is virtually clear. PRIME grade exhibits fine appearance although slightly less restrictive than SUPERIOR. E grade is intended for ripping and cross-cutting to obtain small pieces of PRIME or better quality.

The highest quality, premium cedar grades are typically run-to-pattern into siding or paneling products and may be graded to either the surfaced or a saw-textured side. CLEAR VG HEART is intended for use where only the highest quality is indicated. The exposed width is all heartwood and free from imperfections. A grade allows only minor imperfections and is of fine appearance. Square-edged cedar boards are generally manufactured in SELECT grades.

Common Board grades are determined from the better face and are varying qualities of knotty material. 1 and 2 COMMON are usually sold as 2 & BTR COMMON and intended for paneling, shelving and other uses where a fine appearance in knotty material is desirable. 3 COMMON is also widely used for siding, paneling and shelving as well as for fences, boxes, crating, sheathing and industrial applications. 4 COMMON is more widely used than any other grade for general construction such as subfloors, roof & wall sheathing, concrete forms, low-cost fencing, crating, etc. 5 COMMON is intended for economy-governed applications.

Alternate Board grades are determined from the better face. SELECT MERCHANTABLE is intended for use in housing and light construction where it is exposed as paneling, shelving and where knotty type lumber of fine appearance is desirable. CONSTRUCTION is used for spaced sheathing, let-in bracing, fences, boxes, crating and industrial applications. The uses for STANDARD are similar to a 4 COMMON, as described above.

Special Western Red Cedar general purpose grades (SELECT KNOTTY or QUALITY KNOTTY) are similar in appearance to 2 COMMON and 3 COMMON, and are widely used for siding and landscape applications. Knot size and quality are defined in the grading rules; sound, tight knots do not adversely affect performance. Dry knotty siding must not exceed 19% moisture content, however it may be specified to MC-15 or KD-15. Knotty siding is also sometimes manufactured unseasoned.

RUN-TO-PATTERN PRODUCTS

Board Lumber is the starting material for many products that are run-to-pattern, such as paneling, siding, flooring, ceiling and partition material. In many cases, the grade of the material that has been run-to-pattern reflects the grade of the starting material, adhering to similar requirements for allowable characteristics.

Appearance Lumber

Refer to WWPA's *Natural Wood Siding Technical Guide* (TG-8) for comprehensive information on WWPA and WCLIB siding grades, patterns, specification and installation. Refer to WWPA's *Standard Patterns* (G-16) for paneling, flooring, ceiling, partition (and siding) patterns in profile with dimensions. Contact the Wood Moulding & Millwork Producers Association (P.O. Box 25278, Portland, OR 97225) for moulding and trim patterns in profile.

RADIUS-EDGED PATIO DECKING

Grades/End-Uses - Western Patio Decking is manufactured to be used flat-wise for load-bearing applications where spans are maximum 16" on center. This newly defined product (added to the *Western Lumber Grading Rules* in 1989) offers an excellent option for decks and landscaping applications where Structural Decking or other dimension products would not be sufficiently refined in appearance to suit the end use.

Its thin profile, with oversized eased edges, makes it suitable for outdoor and garden applications such as patio decks, benches, railings, trim and fencing. It may be used for planters and shelving where stock thinner than regular 2" decking is desirable.

Patio Decking is available in two grades: PATIO 1 and PATIO 2.

PATIO 1 is similar in appearance (in terms of limitations on natural characteristic but allowing fewer restrictions with regards to manufacturing imperfections) to a 2 & BTR COM-

MON; whereas PATIO 2 is similar in appearance to the upper end of the 3 COMMON. Refer to page 18 for a description of the COMMON grades.

Patio Decking is manufactured primarily in Ponderosa Pine (which has a cell structure very receptive to pressure treating) and the Western Cedars (which are naturally durable). The Patio grades are gradually becoming available in other Western Lumber species as well.

Both grades may be manufactured in two sizes. Refer to Table 16.

Nailing - Pre-drill holes near the ends of each piece. Use only non-corrosive (stainless steel, high strength aluminum or hot-dipped galvanized) 10d (3") nails or 8d (minimum) deck screws. Use two nails per piece driven one inch in from each edge. Ring- or spiral-shank nails will provide additional holding capacity. Pre-finish edges, ends and surfaces for best results. Refer to paragraph on seasoning lumber (p. 20) for additional information.

STANDARD SIZES PATIO DECKING

Table 16

PATIO 1 & 2	Surfaced DRY	Surfaced GRN
1/4" radius edge	1" x 5 1/2"	1 1/32" x 5 5/8"
3/8" radius edge	1 5/32" x 5 1/2"	1 3/16" x 5 5/8"

STANDARD SIZES-APPEARANCE LUMBER

Table 15

Nominal & Dressed

Based on *Western Lumber Grading Rules*

Product	Description	Nominal Size		Dry Dressed Dimensions		
		Thickness (Inches)	Width (Inches)	Thickness (Inches)	Width (Inches)	Lengths (feet)
SELECTS AND COMMONS	S1S, S2S, S4S, S1S1E, S1S2E	4/4	2	3/4	1 1/2	6' and longer
		5/4	3	1 5/32	2 1/2	in multiples
		6/4	4	1 13/32	3 1/2	of 1' except
		7/4	5	1 19/32	4 1/2	Douglas Fir
		8/4	6	1 13/16	5 1/2	and Larch
		9/4	7	2 3/32	6 1/2	Selects shall be
		10/4	8 & wider	2 3/8	3/4 off	4' and longer
		11/4		2 9/16	nominal	with 3% of 4'
		12/4		2 3/4		and 5'
		16/4		3 3/4		permitted.
FINISH AND ALTERNATE BOARD GRADES	S1S, S2S, S4S, S1S1E, S1S2E	3/8	2	5/16	1 1/2	3' and longer.
		1/2	3	7/16	2 1/2	In Superior
		5/8	4	9/16	3 1/2	grade, 3% of 3'
		3/4	5	5/8	4 1/2	and 4' and 7%
		1	6	3/4	5 1/2	of 5' and 6'
		1 1/4	7	1	6 1/2	are permitted.
		1 1/2	8 & wider	1 1/4	3/4 off	In Prime Grade
		1 3/4		1 3/8	nominal	20% of 3' to 6'
		2		1 1/2		is permitted.
		2 1/2		2		
3		2 1/2				
3 1/2		3				
4		3 1/2				

Abbreviations:

S1S - Surfaced one side
S2S - Surfaced two sides
S4S - Surfaced four sides.

S1S1E - Surfaced one side, one edge.
S1S2E - Surfaced one side, two edges.

Appearance Lumber

SPECIFYING FINISH CARPENTRY MATERIALS

A specification for a Finish or Board Lumber grade should include a reference to the section number, title and edition of the grading rules from which it is written. In other words, if you are specifying from Section 21.11, special Western Red Cedar Rules, WWPA *Western Lumber Grading Rules '91*, so state.

Grain patterns, when desired, can also be specified for Selects, Finish and Special Western Red Cedar grades. Three categories are available: vertical grain (VG), flat grain (FG) or a shipment of both VG and FG, generally referred to as mixed grain (MG). The most readily available and least costly is mixed grain. Unless otherwise specified, siding, paneling and finish boards are shipped with mixed grain. Stair treads, stepping, etc. should be vertical grain as it is more durable.

Board Lumber in Combination with Rough Carpentry Materials - Boards, basically, are 1" nominal thickness. Board grades used in conjunction with rough carpentry materials are generally controlled by building code requirements, and the grades are selected from the Common or Alternate Board grades listed in the appearance lumber grades chart on page 18, Table 14.

As an example, major model building codes recognize NO. 3 COMMON or STANDARD grades as equal minimum grades for spaced roof sheathing even though there are differences in grading characteristics. Verify local building code requirements and dealer availability prior to specifying.

Seasoning Lumber - Once in place, lumber adjusts to its surrounding atmospheric conditions. In a covered structure, lumber will stabilize at approximately 6 to 12% moisture content. Size will vary approximately 1% for each 4% change in moisture content. Thus, it is important that all finish materials be stacked and stickered, in the room where they will be applied, for 7-10 days prior to installation. 2x decking material should be allowed to acclimate for 14 to 21 days prior to installation. The lumber should be stored off the ground, well ventilated and loosely covered. The lumber will then stabilize its moisture content for its permanent location. Staining or priming, where economically feasible, should be done before installation. Refer to WWPA *Paneling Basics* (A-3), *Natural Wood Siding* (TG-8) and *Lumber Storage* (TG-5) for additional information.

Moisture Content - WWPA Finish and Select grades, as well as special Western Red Cedar grades, are shipped seasoned as follows: *S-DRY (or KD)* or *MC-15 (or KD-15)* with at least 85 percent of items not exceeding 12% in moisture content and no portion exceeding 15% moisture content. Appearance grades of Western Lumber are not shipped S-GRN (with a moisture content above 19% at the time of surfacing) except in some of the knotty grades. Refer to page 4 for additional information on moisture content designations in the grade stamp and to WWPA's *Natural Wood Siding* (TG-8) for recommendations on handling unseasoned siding products.

Interior and Exterior Trim and Finish Board Materials -

Select from appearance grades as indicated in Table 14 and described in the WWPA *Western Lumber Grading Rules '91*.

Refer to the WWPA publication, *Vol. 2: Western Wood Species* for color photographs of Select, Finish, Common and Alternate Board grades in many Western Lumber species.

Wood Siding and Paneling Materials - The following publications offer information on selecting pattern type and grade, and summarize installation and handling requirements: *Natural Wood Siding: A Technical Guide* (TG-8), *Siding Basics, A Field Guide* (A-8) and *Paneling Basics* (A-3).

After a general pattern type has been selected, the pattern number should be specified from the WWPA publication *Standard Patterns* (G-16).

When a saw-textured face is desired, the face to be textured and the type of texture (band sawn, rough sawn, circular sawn, etc.) should be specified.

A siding specification should include WWPA's industry recommendations for acclimatization, backpriming, nailing and finishing. Refer to WWPA's *Natural Wood Siding* (TG-8) for details. A checklist and moisture content guidelines are provided below for convenience.

MOISTURE CONTENT GUIDELINES

Uses of Wood	Recommended Moisture Content at Time of Installation					
	Most Areas of the U.S.		Dry, Southwestern States		Damp, Warm South-eastern Coastal Areas	
	Average ¹	Individual Pieces	Average ¹	Individual Pieces	Average ¹	Individual Pieces
Siding, Trim and Sheathing	12%	9-14%	9%	7-12%	12%	9-14%

¹ To obtain a realistic average, test at least 10% of each item, i.e. 10% of the siding pieces, 10% of the trim pieces and random checks of the sheathing material. It is particularly important to check the sheathing prior to the siding application if it has become wet after it was installed.

Source: Wood Handbook, 1987, from Table 14-1.

SIDING OR PANELING MATERIAL SPECIFICATION

Checklist 5

- Select species suited to the project.
- List grade names, paragraph numbers and rules-writing agency. (Refer to Table 14)
- Specify surface texture for exposed face.
- Specify moisture content suited to project.
- If gradestamped, specify lumber be stamped on back or ends. (WWPA's *Lumber Specifying* offers additional information.)
- Specify VG (vertical grain) if appropriate and available.
- Specify pattern and size. (WWPA's *Standard Patterns* offers additional information.)
- Specify installation, nailing and finishing. (WWPA's *Natural Wood Siding* offers additional information.)

Industrial Lumber

INTRODUCTION

This broad category of Western Lumber products includes structural products, some with applied design values, products for remanufacturing purposes and non-structural, miscellaneous products for a variety of specific applications. Classifications and grades are indicated in the chart below.

INDUSTRIAL LUMBER

Structural Products	Remanufacturing Products (non-structural)	Non-Structural Products
Mining Timbers	Factory,	Gutter
Scaffold Plank	Moulding & Btr Grades,	Picket
Foundation Lumber	Shop Lumber, etc.	Lath
Stress-Rated Boards		Battens
		Stepping

STRUCTURAL PRODUCTS

Mining Timbers are designed primarily for use as shoring and bracing materials in mines and tunnels. The grades are designed for serviceability, not necessarily appearance. There are two grades: NO. 1 MINING and NO. 2 MINING. Both are graded full length. No design values are applied. Nominal sizes are 5" and thicker, 5" and wider. Refer to Sections 81.11 & 81.12 in the WWPAs *Western Lumber Grading Rules* for additional information.

Scaffold Plank is shipped rough & unseasoned in Douglas Fir-Larch, 1 1/4" and thicker, 8" and wider, in two grades (SCAFFOLD NO. 1 and SCAFFOLD NO. 2) with applied design values.

SCAFFOLD PLANK

Douglas Fir & Larch

Design Values—For Flatwise Use

Table 17

Thickness	Grade	Extreme Fiber Stress in Bending (F _b) in psi	Modulus of Elasticity (E) in psi
2" & less	No. 1	2350	1,800,000
	No. 2	2200	1,800,000
3"	No. 1	1800	1,600,000
	No. 2	1650	1,600,000

These values apply to dry use conditions. For wet use conditions, these values shall be multiplied by 0.86 for F_b and 0.97 for E.

These values apply to both dry and wet use conditions.

Bending Stresses (F_b) for Scaffold Plank grades have incorporated a scaffold use factor according to the American National Standards Institute (ANSI) Standard A10.8. This factor modifies the allowable bending stresses to the equivalent safety level of four times the design load without failure.

Foundation Lumber is occasionally used for sill plates. It is available only in Western Red Cedar and Incense Cedar, in sizes 2" and thicker, 4" and wider. There is only one grade: FOUNDATION. It is selected from heartwood (naturally decay resistant) and must be free of heart center and free of sapwood. It is manufactured rough sawn or surfaced. Where surfaced, the sizes are the same as for Dimension Lumber or Timbers, Table 6, page 13. Refer to Section 54.00 of WWPAs *Western Lumber Grading Rules* for additional information.

Stress-Rated Boards - Stress-rated boards are available from Western Lumber manufacturers in all species to provide a range of products suitable for special applications when Board Lumber is to have applied design values. Several such uses include light trusses, belt rails, horizontal bracing, rafters and box beams for mobile and factory built homes. Design values are the same as those shown in Table 1, page 6. Apply all appropriate adjustments for BASE VALUES, Tables A-G. When Stress-Rated Boards are gradestamped, the grade name or number for the dimension grades will be shown on the grade stamp along with "SRB" designating Stress-Rated Board. Refer to Section 30.60 of the *Western Lumber Grading Rules* for additional information.

STANDARD SIZES* STRESS-RATED BOARDS

Table 18

Nominal	Surfaced Dry	Surfaced Unseasoned
1, 1 1/4, 1 1/2"	Thickness 3/4, 1, 1 1/4"	25/32, 1 1/32, 1 9/32"
	Widths	
2"	1 1/2"	1 9/16"
3"	2 1/2"	2 9/16"
4"	3 1/2"	3 9/16"
5"	4 1/2"	4 5/8"
6"	5 1/2"	5 5/8"
8" and wider	3/4" off nominal	1/2" off nominal

*Standard lengths are 6' and longer in multiples of 1'

REMANUFACTURING PRODUCTS

Factory and Shop Grades provide the remanufacturer with an opportunity to buy industrial lumber, intended for the recovery of clear pieces, at an economical price. These grades, available primarily in Douglas Fir, Hem-Fir, Ponderosa Pine and Sugar Pine, are especially well suited for remanufacture to obtain clear, standard-size cuttings that are based on typical U.S. joinery and millwork cutting sizes. Grades include MOULDING STOCK, CLEAR DOOR, FACTORY SELECT, (NO. 3 CLEAR), NO. 1 SHOP, NO. 2 SHOP, NO. 3 SHOP, and FINGERJOINT SHOP COMMON. Refer to WWPAs *Vol. 3: Western Wood Species* book on *Factory Lumber* or the *Western Lumber Grading Rules* for additional information. Standard sizes are shown in Table 19 on the following page.

STANDARD SIZES FACTORY LUMBER

Nominal & Dressed

Based on WWPAs Western Lumber Grading Rules

Product	Description	Nominal Size		(Dry) Dressed Dimensions			
		Thickness	Width	Thickness	Face Width	Lengths	
FACTORY AND SHOP LUMBER	S2S (Surfaced two sides)	1"	(4/4)	See individual descriptions WWPA's <i>Western Lumber Grading Rules '91</i>	3/4"	(4/4)	Usually sold random width multiples of 2'
		1 1/4"	(5/4)		1 5/32"	(5/4)	
		1 1/2"	(6/4)		1 13/32"	(6/4)	
		1 3/4"	(7/4)		1 19/32"	(7/4)	
		2"	(8/4)		1 13/16"	(8/4)	
		2 1/2"	(10/4)		2 3/8"	(10/4)	
3"	(12/4)	2 3/4"	(12/4)				
4"	(16/4)	3 3/4"	(16/4)				

NON-STRUCTURAL PRODUCTS

Gutter (WCLIB grade) is available in some Western species and shipped in a number of patterns. It is available in one grade, GUTTER, and usually (but not necessarily) measures 4" x 5" x 20'. Pieces of this grade are of sound wood and are water tight. Refer to paragraph 112 in *WCLIB Standard Grading Rules*.

Pickets (WCLIB grade) are available in any Western species and are shipped kiln-dried (KD) or unseasoned (S-GRN). Grades, NO. 1 and NO. 2, are based on a piece 1" x 3" x 4'. Standard sizes are shown below.

STANDARD PICKET SIZES

Table 20

Nominal	Net
1 1/4" square	S4S to 1 1/16" x 1 1/16"
1 1/2" square	S4S to 1 5/16" x 1 5/16"
1" x 3" flat	S4S to 3/4" x 2 1/2"

Lath is available in any Western species, in two grades, NO. 1 & NO. 2, and may be shipped dry or unseasoned. Sizes are 3/8" thick by 1 1/2" wide, 32" or 48" long.

Battens (WCLIB grade) are available in any Western species, in one grade: BATTENS. They are surfaced S1S1E or S4S at shipper's option, unless specified otherwise. Grade is based on a piece 12' long. Standard widths are shown below.

STANDARD BATTEN SIZES

Table 21

Pattern	Nominal	Net
Flat	3"	1/4" x 1 1/2"
O.G.	2"	3/4" x 1 3/4"
O.G.	2 1/2"	3/4" x 2 1/4"
O.G.	3"	3/4" x 2 1/2"

Stepping (WCLIB grade) is typically vertical grained (VG) and kiln dried (KD) and customarily surfaced on three sides with a bull nose on one edge. The recommended standard for STEPPING of 1 1/4" thickness is to round the nosed edge to a radius of 5/8". Grades are based on a piece 12" wide by 12' long. There are two grades: C&BTR - VG STEPPING and D - VG STEPPING. Refer to paragraph 109 in *WWPA Western Lumber Grading Rules*.

SPECIFYING INDUSTRIAL LUMBER PRODUCTS

It is important to realize that not all products, grades and sizes in the industrial products category are readily available at all times. These products are rarely available through standard retail outlets as they are usually traded at the wholesale level, often as custom orders, or bought mill direct in large volumes.

WWPA's *Vol. 3 Species* book on *Factory Lumber* includes full-color photographs of the grades intended for cut up. This species brochure aids remanufacturers in determining which grades are best-suited for the recovery of specifically-sized pieces.

In general, industrial products are specified according to the following elements:

Grade Description - refer to specific paragraph number in the *Western Lumber Grading Rules*.

Moisture Content - specify MC as dictated by grading rules or according to specific requirements for intended end use, realizing that "specific requirements" are available only through manufacturer/customer agreement.

Species - specify all species that are appropriate.

Profile/Surface Texture - specify when appropriate.

Sizes and Lengths - always specify all sizes and lengths that are appropriate to the application.

WWPA Field Services may be contacted for help with industrial product specification whenever necessary.

Relative Properties of Western Species

WESTERN SPECIES DIMENSIONAL STABILITY

Wood shrinks as it seasons (dries) from the fiber saturation point (of 28% to 30% MC) to the moisture level of surrounding atmospheric conditions. Within most structures, this moisture content level is between 8% and 12%.

In one- and two-story structures, the cumulative effect of shrinkage can be accommodated on the jobsite, even when unseasoned lumber is specified. However, for three story and higher buildings, designs should allow for shrinkage in the horizontal members, e.g. wall plates and joists.

The shrinkage of Western species (except Western Cedars) is approximately 6% as it dries from 30% to 0% MC (4.5% for Western Cedars), i.e. 0.2% shrinkage for every 1% change in moisture content for Western species and 0.15% for Western Cedars. The shrinkage factor assumes a growth-ring angle of 45° and is an average for multiple species.

Example: To calculate the amount of shrinkage in a 2x10 Hem-Fir floor joist, manufactured at 19% (S-Dry) with an equilibrium moisture content of 8%:

$$9.25 \text{ inches width (actual width of dry 2x10)} \times 0.002 \text{ shrinkage factor (.2\% = .002)} \times 11 \text{ \% change in moisture content (19 - 8 = 11)} = 0.20 \text{ inches}$$

Vertical members exhibit less dimensional change because wood's longitudinal shrinkage is quite small (approximately .003 to .0067 percent for every 1% change in MC).

Shrinkage factors for individual species and specific grain orientations can be found in WWPA's *Dimensional Stability Technical Guide* (TG-3). For additional information on shrinkage in multi-story wood frame systems, consult WWPA's *Wood Frame Design* (556).

FLAME SPREAD RATINGS AND SMOKE-DEVELOPED INDICES

The Underwriters' Laboratory Test Method establishes a numerical scale for flame spread based upon a non-combustible, asbestos-cement board as 0 (zero) and a combustible Red Oak as 91. Shown below are the flame-spread ratings and smoke-developed indices and classifications for untreated Western species.

FLAME SPREAD RATINGS FOR WESTERN SPECIES

Table 22

Species	Flame-spread	Smoke-Developed Index
Douglas Fir	90	70
Western Hemlock	73	80
Western Spruce	100	*
Lodgepole Pine	98	90
Idaho White Pine	82	83
Ponderosa Pine	105-230	*
Western Red Cedar	69	137
Model Building Code Classifications:	0-25 flame spread	Class 1 or A
	26-75 flame spread	Class 2 or B
	76-200 flame spread	Class 3 or C

* No recent data is available.

WEIGHT PER LINEAR FOOT

To calculate the weight per linear foot for a particular size and species, multiply the cross-sectional area of the member by the species weight and increase factors shown below. The weight factors apply to lumber at 15% MC.

WEIGHT FACTOR

Table 23

Species or Species Group	Weight Factor	Species or Species Group	Weight Factor
Douglas Fir-Larch	.233	Western Cedars	
Douglas Fir-South	.216	Western Red Cedar	.162
Hem-Fir	.203	Alaskan Yellow Cedar	.220
Spruce-Pine-Fir (South)	.203	Port Orford Cedar	.205
Western Woods		Incense Cedar	.183
Ponderosa Pine	.203		
Idaho White Pine	.194		
Sugar Pine	.184		
Alpine Fir	.170		
Mountain Hemlock	.220		

Weight Increase Factors*

Moisture Content	Increase Factor	Moisture Content	Increase Factor
20%	1.044	50%	1.314
30%	1.140	60%	1.392
40%	1.218	70%	1.488

*Weight factors are based on the most recently available wood density data.

Example: Weight for three feet of 2x8 DF-L @ 30% MC.

$$3 \text{ x } 1.5 \text{ x } 7.5 \text{ x } .233 \text{ x } 1.140 = 8.97 \text{ pounds}$$

actual size of unseasoned 2x8 weight factor for DF-L increase factor for 30% MC

Relative Properties of Western Species

SPECIFIC GRAVITY

Variations in the size of the cell cavities and pores and in the thickness of the cell walls cause some species to have more wood substance per unit volume than others, and therefore to have a higher specific gravity. Thus specific gravity provides an index to one species' density in relation to other species. The higher the number, the higher the specific gravity or density.

SPECIFIC GRAVITY OF WESTERN SOFTWOOD SPECIES¹ Table 24

Western Species	Specific Gravity Oven Dry Weight/ Oven Dry Volume
DOUGLAS FIR-LARCH	.50
Douglas Fir	
Western Larch	
DOUGLAS FIR-SOUTH	.46
Douglas Fir-South	
HEM-FIR	.43
Western Hemlock	
Noble Fir	
California Red Fir	
Grand Fir	
Pacific Silver Fir	
White Fir	
SPRUCE-PINE-FIR (South)	.36
Engelmann Spruce	
Sitka Spruce	
Lodgepole Pine	
MACHINE STRESS RATED SPRUCE-PINE-FIR (South) or ENGELMANN SPRUCE- LOGEPOLE PINE	
MSR 1650 & higher grades	.46
MSR 1500 & lower grades	.38
WESTERN CEDARS	.36
Western Red Cedar	
Incense Cedar	
Port Orford Cedar	
Alaska Cedar	
WESTERN WOODS	.36
Idaho White Pine	
Ponderosa Pine	
Sugar Pine	
Alpine Fir	
Mountain Hemlock	

¹ National Design Specifications for Wood Construction, 1991.

THERMAL CONDUCTIVITY

The relatively low thermal conductivity or "k" of Western softwoods provides a significant amount of insulation. k is the amount of heat (Btu's) transferred in one hour through one square foot of material one inch thick with a difference in temperature of 1° F.

The thermal conductivity of wood increases with increased moisture content and with increased density. The k values for the Western Woods are shown in the table below.

THERMAL CONDUCTIVITY OF WESTERN SPECIES Table 25

Species	k*	R/in.
Douglas Fir-Larch	1.06	.94
Douglas Fir-South	.99	1.01
Hem-Fir	.92	1.08
Spruce-Pine-Fir (South)		
Engelmann Spruce	.80	1.25
Lodgepole Pine	.92	1.08
Western Woods		
Ponderosa Pine/Sugar Pine	.89	1.12
Idaho White Pine	.84	1.19
Alpine Fir	.75	1.33
Mountain Hemlock	.98	1.02
Western Cedars	.75	1.33

*k values shown are for wood with 12% moisture content. For other moisture contents, there is a change in k of approximately .01 for each 1% moisture content difference—an increase in k for an increase in moisture content and a decrease in k for a decrease in moisture content.

If you need additional information on Western Lumber, would like to order WWPA literature or are interested in WWPA seminars for design professionals, contact the Portland office at the address and telephone number below.



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