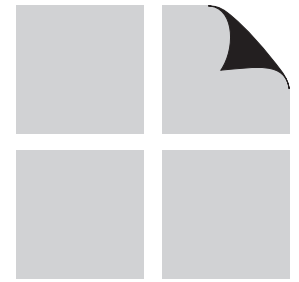


**2005 EDITION**



**S U P P L E M E N T**

**N D S<sup>®</sup>**

**NATIONAL DESIGN SPECIFICATION<sup>®</sup>**

**DESIGN VALUES FOR  
WOOD CONSTRUCTION**

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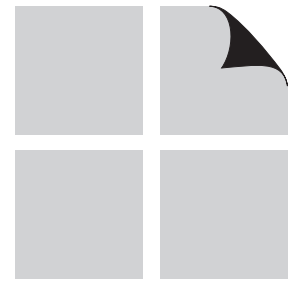
**American Wood Council**

## **Updates and Errata**

While every precaution has been taken to ensure the accuracy of this document, errors may have occurred during development. Updates or Errata are posted to the American Wood Council website at [www.awc.org](http://www.awc.org). Technical inquiries may be addressed to [awcinfo@afandpa.org](mailto:awcinfo@afandpa.org).

*The American Wood Council (AWC) is the wood products division of the American Forest & Paper Association (AF&PA). AF&PA is the national trade association of the forest, paper, and wood products industry, representing member companies engaged in growing, harvesting, and processing wood and wood fiber, manufacturing pulp, paper, and paperboard products from both virgin and recycled fiber, and producing engineered and traditional wood products. For more information see [www.afandpa.org](http://www.afandpa.org).*

**2005 Edition**



**S U P P L E M E N T**

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**DESIGN VALUES FOR  
WOOD CONSTRUCTION**

## Introduction

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This Supplement is an integral part of the *National Design Specification® (NDS®) for Wood Construction*, 2005 Edition. It provides reference design values for structural sawn lumber and structural glued laminated timber.

### Lumber

The reference design values for lumber in this Supplement are obtained from grading rules published by seven agencies: National Lumber Grades Authority (a Canadian agency), Northeastern Lumber Manufacturers Association, Northern Softwood Lumber Bureau, Redwood Inspection Service, Southern Pine Inspection Bureau, West Coast Lumber Inspection Bureau, and Western Wood Products Association. The grading rules promulgated by these agencies, including the reference design values therein, have been approved by the Board of Review of the American Lumber Standards Committee and certified for conformance with U.S. Department of Commerce Voluntary Product Standard PS 20-99 (American Softwood Lumber Standard).

Reference design values for most species and grades of visually graded dimension lumber are based on the provisions of ASTM Standard D 1990-00<sup>e1</sup> (Establishing Allowable Properties for Visually Graded Dimension Lumber from In-Grade Tests of Full-Size Specimens). Reference design values for visually graded timbers, decking, and some species and grades of dimension lumber are based on the provisions of ASTM Standard D 245-00<sup>e1</sup> (Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber). The methods in ASTM Standard D 245-00<sup>e1</sup> involve adjusting the strength properties of small clear specimens of wood, as given in ASTM Standard D 2555-98 (Establishing Clear Wood Strength Values), for the effects of knots, slope of grain, splits, checks, size, duration of load, moisture content, and other influencing factors, to obtain reference design values applicable to normal conditions of service. Lumber structures designed on the basis of working stresses derived from ASTM Standard D 245 procedures and standard design criteria have a long history of satisfactory performance.

Reference design values for machine stress rated (MSR) lumber and machine evaluated lumber (MEL) are based on nondestructive testing of individual pieces. Certain visual grade requirements also apply to such lumber. The stress rating system used for MSR and MEL lumber is regularly checked by the responsible grading agency for conformance to established certification and quality control procedures.

For additional information on development and applicability of lumber reference design values, the grading rules published by the individual agencies and the referenced ASTM Standards should be consulted.

### Structural Glued Laminated Timber

Reference design values in this Supplement for structural glued laminated timber are developed and published by the American Institute of Timber Construction (AITC) and APA–The Engineered Wood Association (APA) in accordance with principles originally established by the U.S. Forest Products Laboratory in the early 1950s. These principles involve adjusting strength properties of clear straight grained lumber to account for knots, slope of grain, density, size of member, number of laminations, and other factors unique to laminated timber.

Specific methods used to establish reference design values have been periodically revised and improved to reflect the results of tests of large structural glued laminated timber members conducted by the U.S. Forest Products Laboratory and other accredited testing agencies. The performance history of structures made with structural glued laminated timber conforming to AITC specifications and manufactured in accordance with American National Standard ANSI/AITCA 190.1-2002 (Structural Glued Laminated Timber) has demonstrated the validity of the methods used to establish structural glued laminated timber reference design values.

### Conditions of Use

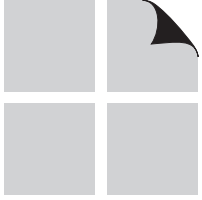
Reference design values presented in this Supplement are for normal load duration under dry conditions of service. Because the strength of wood varies with conditions under which it is used, these reference design values should only be applied in conjunction with appropriate design and service recommendations from the *NDS*. Additionally, the reference design values in this Supplement apply only to material identified by the grade mark of, or certificate of inspection issued by, a grading or inspection bureau or agency recognized as being competent.

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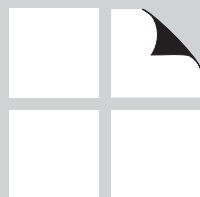
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# SAWN LUMBER GRADING AGENCIES

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## 1.1 List of Sawn Lumber Grading Agencies s2



## 1.1 List of Sawn Lumber Grading Agencies

Following is a list of agencies certified by the American Lumber Standard Committee Board of Review (as of 2004) for inspection and grading of untreated lumber under the rules indicated. For the most up-to-date list of certified agencies contact:

American Lumber Standard Committee  
P.O. Box 210  
Germantown, Maryland 20875-0210  
www.alsc.org

### Rules Writing Agencies

### Rules for which grading is authorized

Northeastern Lumber Manufacturers Association (NELMA) ..... 272 Tuttle Road, P.O. Box 87A, Cumberland Center, Maine 04021	NELMA, NLGA, NSLB, SPIB, WCLIB, WWPA
Northern Softwood Lumber Bureau (NSLB) ..... 272 Tuttle Road, P.O. Box 87A, Cumberland Center, Maine 04021	NLGA, NSLB, WCLIB, WWPA
Redwood Inspection Service (RIS) ..... 405 Enfrente Drive, Suite 200, Novato, California 94949	RIS, WCLIB, WWPA
Southern Pine Inspection Bureau (SPIB) ..... 4709 Scenic Highway, Pensacola, Florida 32504	NELMA, NLGA, NSLB, SPIB, WCLIB, WWPA
West Coast Lumber Inspection Bureau (WCLIB) ..... 6980 SW Varnes Road, P.O. Box 23145, Tigard, Oregon 97223	NLGA, RIS, SPIB, WCLIB, WWPA
Western Wood Products Association (WWPA) ..... 522 SW Fifth Avenue, Suite 500, Portland, Oregon 97204	NLGA, RIS, SPIB, WCLIB, WWPA
National Lumber Grades Authority (NLGA) 960 Quayside Dr., New Westminster, BC, Canada V3M 6G2	

### Non-Rules Writing Agencies

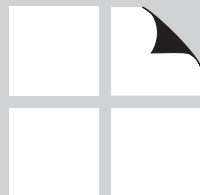
Pacific Lumber Inspection Bureau, Inc. ....	RIS, WCLIB, WWPA, NLGA
Renewable Resource Associates, Inc. ....	NELMA, NLGA, NSLB, SPIB, WCLIB, WWPA
Stafford Inspection and Consulting, LLC .....	SPIB
Timber Products Inspection .....	NELMA, NLGA, NSLB, RIS, SPIB, WCLIB, WWPA
Alberta Forest Products Association .....	NLGA
Canadian Lumbermen's Association .....	NELMA, NLGA
Canadian Mill Services Association .....	NLGA, WWPA
Canadian Softwood Inspection Agency, Inc. ....	NLGA, WCLIB, WWPA
Central Forest Products Association .....	NELMA, NLGA
Council of Forest Industries .....	NLGA, WWPA
Macdonald Inspection .....	NLGA, WCLIB, WWPA
Maritime Lumber Bureau .....	NELMA, NLGA
Newfoundland and Labrador Lumber Producers Association .....	NLGA
Ontario Lumber Manufacturers Association .....	NELMA, NLGA
Pacific Lumber Inspection Bureau .....	NLGA, RIS, WCLIB, WWPA
Quebec Forest Industry Council .....	NELMA, NLGA



# SPECIES COMBINATIONS

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- |            |   |           |
|------------|---|-----------|
| <b>2.1</b> | <b>List of Sawn Lumber Species<br/>Combinations</b>                       | <b>s4</b> |
| <b>2.2</b> | <b>List of Non-North American Sawn<br/>Lumber Species Combinations</b>    | <b>s8</b> |
| <b>2.3</b> | <b>List of Structural Glued Laminated<br/>Timber Species Combinations</b> | <b>s9</b> |



## 2.1 List of Sawn Lumber Species Combinations

Species or Species Combination	Species That May Be Included in Combination	Grading Rules Agencies	Design Values Provided in Tables
Alaska Cedar		WCLIB	4A
Alaska Hemlock		WWPA	4A
Alaska Spruce	Alaska Sitka Spruce Alaska White Spruce	WWPA	4A
Alaska Yellow Cedar		WCLIB, WWPA	4A
Aspen	Big Tooth Aspen Quaking Aspen	NELMA NSLB WWPA	4A
Baldcypress		SPIB	4A, 4D
Balsam Fir		NELMA NSLB	4D, 4E
Beech-Birch-Hickory	American Beech Bitternut Hickory Mockernut Hickory Nutmeg Hickory Pecan Hickory Pignut Hickory Shagbark Hickory Shellbark Hickory Sweet Birch Water Hickory Yellow Birch	NELMA	4A, 4D
Coast Sitka Spruce		NLGA	4D, 4E
Coast Species	Amabilis Fir Coast Sitka Spruce Douglas Fir Western Hemlock Western Larch	NLGA	4E
Cottonwood		NSLB	4A
Douglas Fir-Larch	Douglas Fir Western Larch	WCLIB WWPA	4A, 4C, 4D, 4E
Douglas Fir-Larch (North)	Douglas Fir Western Larch	NLGA	4A, 4C, 4D, 4E
Douglas Fir-South		WWPA	4A, 4C, 4D, 4E
Eastern Hemlock		NELMA NSLB	4D
Eastern Hemlock-Balsam Fir	Balsam Fir Eastern Hemlock Tamarack	NELMA	4A
Eastern Hemlock-Tamarack	Eastern Hemlock Tamarack	NELMA NSLB	4A, 4D, 4E
Eastern Hemlock-Tamarack (North)	Eastern Hemlock Tamarack	NLGA	4D, 4E

## 2.1 List of Sawn Lumber Species Combinations (Cont.)

Species or Species Combination	Species That May Be Included in Combination	Grading Rules Agencies	Design Values Provided in Tables
Eastern Softwoods	Balsam Fir Black Spruce Eastern Hemlock Eastern White Pine Jack Pine Norway (Red) Pine Pitch Pine Red Spruce Tamarack White Spruce	NELMA NSLB	4A
Eastern Spruce	Black Spruce Red Spruce White Spruce	NELMA NSLB	4D, 4E
Eastern White Pine		NELMA NSLB	4A, 4D, 4E
Eastern White Pine (North)		NLGA	4E
Hem-Fir	California Red Fir Grand Fir Noble Fir Pacific Silver Fir Western Hemlock White Fir	WCLIB WWPA	4A, 4C, 4D, 4E
Hem-Fir (North)	Amabilis Fir Western Hemlock	NLGA	4A, 4C, 4D, 4E
Mixed Maple	Black Maple Red Maple Silver Maple Sugar Maple	NELMA	4A, 4D
Mixed Oak	All Oak Species graded under NELMA rules	NELMA	4A, 4D
Mixed Southern Pine	Any species in the Southern Pine species combination, plus either or both of the following: Pond Pine Virginia Pine	SPIB	4B, 4C, 4D
Mountain Hemlock		WWPA, WCLIB	4D
Northern Pine	Jack Pine Norway (Red) Pine Pitch Pine	NELMA NSLB	4D, 4E
Northern Red Oak	Black Oak Northern Red Oak Pin Oak Scarlet Oak	NELMA	4A, 4D
Northern Species	Any species graded under NLGA rules except Red Alder, White Birch, and Norway Spruce	NLGA	4A, 4C, 4E
Northern White Cedar		NELMA	4A, 4D, 4E
Ponderosa Pine		NLGA	4D, 4E

## 2.1 List of Sawn Lumber Species Combinations (Cont.)

Species or Species Combination	Species That May Be Included in Combination	Grading Rules Agencies	Design Values Provided in Tables
Red Maple		NELMA	4A, 4D
Red Oak	Black Oak Cherrybark Oak Laurel Oak Northern Red Oak Pin Oak Scarlet Oak Southern Red Oak Water Oak Willow Oak	NELMA	4A, 4D
Red Pine		NLGA	4D, 4E
Redwood		RIS	4A, 4D, 4E
Sitka Spruce		WWPA, WCLIB	4D, 4E
Southern Pine	Loblolly Pine Longleaf Pine Shortleaf Pine Slash Pine	SPIB	4B, 4C, 4D, 4E
Spruce-Pine-Fir	Alpine Fir Balsam Fir Black Spruce Engelmann Spruce Jack Pine Lodgepole Pine Red Spruce White Spruce	NLGA	4A, 4C, 4D, 4E
Spruce-Pine-Fir (South)	Balsam Fir Black Spruce Engelmann Spruce Jack Pine Lodgepole Pine Norway (Red) Pine Red Spruce Sitka Spruce White Spruce	NELMA NSLB WCLIB WWPA	4A, 4C, 4D, 4E
Western Cedars	Alaska Cedar Incense Cedar Port Orford Cedar Western Red Cedar	WCLIB WWPA	4A, 4C, 4D, 4E
Western Cedars (North)	Pacific Coast Yellow Cedar Western Red Cedar	NLGA	4D, 4E
Western Hemlock		WWPA, WCLIB	4D, 4E
Western Hemlock (North)		NLGA	4D, 4E
Western White Pine		NLGA	4D, 4E

## 2.1 List of Sawn Lumber Species Combinations (Cont.)

Species or Species Combination	Species That May Be Included in Combination	Grading Rules Agencies	Design Values Provided in Tables
Western Woods	Any species in the Douglas Fir-Larch, Douglas Fir-South, Hem-Fir, and Spruce-Pine-Fir (South) species combinations, plus any or all of the following: Alpine Fir Idaho White Pine Mountain Hemlock Ponderosa Pine Sugar Pine	WCLIB WWPA	4A, 4C, 4D, 4E
White Oak	Bur Oak Chestnut Oak Live Oak Overcup Oak Post Oak Swamp Chestnut Oak Swamp White Oak White Oak	NELMA	4A, 4D
Yellow Poplar		NSLB	4A

## 2.2 List of Non-North American Sawn Lumber Species Combinations

Species or Species Combination	Species That May Be Included in Combination	Grading Rules Agency	Design Values Provided in Tables
Austrian Spruce - Austria & The Czech Republic		WCLIB	4F
Douglas Fir/European Larch - Austria, The Czech Republic, & Bavaria	Douglas Fir European Larch	WCLIB	4F
Montane Pine - South Africa		WCLIB	4F
Norway Spruce - Estonia & Lithuania		WCLIB	4F
Norway Spruce - Finland		WCLIB	4F
Norway Spruce - Germany, NE France, & Switzerland		WCLIB	4F
Norway Spruce - Romania & the Ukraine		WCLIB	4F
Norway Spruce - Sweden		WCLIB	4F
Scots Pine - Austria, The Czech Republic, Romania, & the Ukraine		WCLIB	4F
Scots Pine - Estonia & Lithuania		WCLIB	4F
Scots Pine - Finland		WCLIB	4F
Scots Pine - Germany*		WCLIB	4F
Scots Pine - Sweden		WCLIB	4F
Silver Fir ( <i>Abies alba</i> ) - Germany, NE France, & Switzerland		WCLIB	4F
Southern Pine - Misiones Argentina		SPIB	4F
Southern Pine - Misiones Argentina, Free of Heart Center and Medium Grade Density		SPIB	4F

\* Does not include states of Baden-Wurtemberg and Saarland.

## 2.3 List of Structural Glued Laminated Timber Species Combinations

Species or Species Group	Symbol	Species That May Be Included in Group	Design Values Provided in Tables
Alaska Cedar	AC	Alaska Cedar	5A, 5B
Douglas Fir-Larch	DF	Douglas Fir, Western Larch	5A, 5B
Hem-Fir	HF	California Red Fir Grand Fir Noble Fir Pacific Silver Fir Western Hemlock White Fir	5A, 5B
Softwood Species	SW	Alpine Fir Balsam Fir Black Spruce Douglas Fir Douglas Fir South Engelmann Spruce Idaho White Pine Jack Pine Lodgepole Pine Mountain Hemlock Ponderosa Pine Red Spruce Sugar Pine Western Larch Western Red Cedar White Spruce	5A, 5B
Southern Pine	SP	Loblolly Pine Longleaf Pine Shortleaf Pine Slash Pine	5A, 5B

## 2.3 List of Structural Glued Laminated Timber Species Combinations (Cont.)

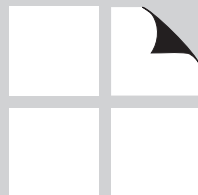
Species or Species Group	Symbol	Species That May Be Included in Group	Design Values Provided in Tables
Group A Hardwoods	A	Ash, White Beech, American Birch, Sweet Birch, Yellow Hickory, Bitternut Hickory, Mockernut Hickory, Nutmeg Hickory, Pecan Hickory, Pignut Hickory, Shagbark Hickory, Shellbark Hickory, Water Oak, Northern Red Oak, White	5C, 5D
Group B Hardwoods	B	Elm, Rock Maple, Black Maple, Red Mixed Oak: Black Bur Cherrybark Chestnut Laurel Live Northern Red Overcup Pin Post Scarlet Southern Red Swamp Chestnut Swamp White Water White Sweetgum	5C, 5D
Group C Hardwoods	C	Ash, Black Elm, American Tupulo, Water Yellow Poplar	5C, 5D
Group D Hardwoods	D	Aspen, Bigtooth Aspen, Quaking Cottonwood, Eastern Mixed Maple: Black Red Silver Sugar	5C, 5D



# SECTION PROPERTIES

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<b>3.1</b>	<b>Section Properties of Sawn Lumber and Structural Glued Laminated Timber</b>	<b>s12</b>
<b>Table 1A</b>	<b>Nominal and Minimum Dressed Sizes of Sawn Lumber .....</b>	<b>s13</b>
<b>Table 1B</b>	<b>Section Properties of Standard Dressed (S4S) Sawn Lumber .....</b>	<b>s14</b>
<b>Table 1C</b>	<b>Section Properties of <i>Western Species</i> Structural Glued Laminated Timber .....</b>	<b>s16</b>
<b>Table 1D</b>	<b>Section Properties of <i>Southern Pine</i> Structural Glued Laminated Timber .....</b>	<b>s22</b>



## 3.1 Section Properties of Sawn Lumber and Structural Glued Laminated Timber

### 3.1.1 Standard Sizes of Sawn Lumber

Details regarding the dressed sizes of various species of lumber in the grading rules of the agencies which formulate and maintain such rules. The dressed sizes in Table 1A conform to the sizes set forth in U.S. Department of Commerce Voluntary Product Standard PS 20-99 (American Softwood Lumber Standard). While these sizes are generally available on a commercial basis, it is good practice to consult the local lumber dealer to determine what sizes are on hand or can be readily secured.

Dry lumber is defined as lumber which has been seasoned to a moisture content of 19% or less. Green lumber is defined as lumber having a moisture content in excess of 19%.

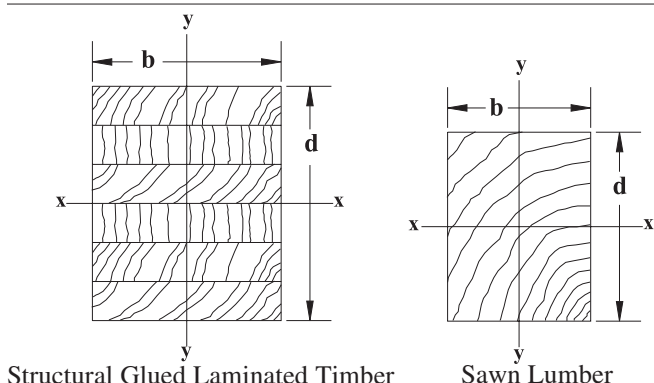
### 3.1.2 Properties of Standard Dressed Sizes

Certain mathematical expressions of the properties or elements of sections are used in design calculations for various member shapes and loading conditions. The section properties for selected standard sizes of boards, dimension lumber, and timbers are given in Table 1B. Section properties for selected standard sizes of structural glued laminated timber are given in Table 1C and 1D.

### 3.1.3 Definitions

NEUTRAL AXIS, in the cross section of a beam, is the line on which there is neither tension nor compression stress.

**Figure 1A Dimensions for Rectangular Cross Section**



MOMENT OF INERTIA,  $I$ , of the cross section of a beam is the sum of the products of each of its elementary areas multiplied 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 the extreme fiber of the section.

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

The following symbols and formulas apply to rectangular beam cross sections:

X-X = neutral axis for edgewise bending (load applied to narrow face)

Y-Y = neutral axis for flatwise bending (load applied to wide face)

$b$  = breadth of rectangular bending member, in.

$d$  = depth of rectangular bending member, in.

$A = bd$  = area of cross section, in.<sup>2</sup>

$c$  = distance from neutral axis to extreme fiber of cross section, in.

$I_x = bd^3/12$  = moment of inertia about the X-X axis, in.<sup>4</sup>

$I_y = db^3/12$  = moment of inertia about the Y-Y axis, in.<sup>4</sup>

$r_x = \sqrt{I_x/A} = d/\sqrt{12}$  = radius of gyration about the X-X axis, in.

$r_y = \sqrt{I_y/A} = b/\sqrt{12}$  = radius of gyration about the Y-Y axis, in.

$S_x = I_x/c = bd^2/6$  = section modulus about the X-X axis, in.<sup>3</sup>

$S_y = I_y/c = db^2/6$  = section modulus about the Y-Y axis, in.<sup>3</sup>

The following formula shall be used to determine the density in lb./ft.<sup>3</sup> of wood:

$$\text{density} = 62.4 \left[ \frac{G}{1 + G(0.009)(\text{m.c.})} \right] \left[ 1 + \frac{\text{m.c.}}{100} \right]$$

where:

$G$  = specific gravity of wood (see NDS Table 11.3.2A)

m.c. = moisture content of wood, %

**Table 1A Nominal and Minimum Dressed Sizes of Sawn Lumber**

Item	Thickness (in.)			Face Widths (in.)			
	Nominal	Minimum dressed		Nominal	Minimum dressed		
		Dry	Green		Dry	Green	
Boards	3/4	5/8	11/16	2	1-1/2	1-9/16	
	1	3/4	25/32	3	2-1/2	2-9/16	
	1-1/4	1	1-1/32	4	3-1/2	3-9/16	
	1-1/2	1-1/4	1-9/32	5	4-1/2	4-5/8	
				6	5-1/2	5-5/8	
				7	6-1/2	6-5/8	
				8	7-1/4	7-1/2	
				9	8-1/4	8-1/2	
				10	9-1/4	9-1/2	
				11	10-1/4	10-1/2	
				12	11-1/4	11-1/2	
				14	13-1/4	13-1/2	
				16	15-1/4	15-1/2	
	Dimension Lumber	2	1-1/2	1-9/16	2	1-1/2	1-9/16
		2-1/2	2	2-1/16	3	2-1/2	2-9/16
		3	2-1/2	2-9/16	4	3-1/2	3-9/16
3-1/2		3	3-1/16	5	4-1/2	4-5/8	
4		3-1/2	3-9/16	6	5-1/2	5-5/8	
4-1/2		4	4-1/16	8	7-1/4	7-1/2	
				10	9-1/4	9-1/2	
				12	11-1/4	11-1/2	
				14	13-1/4	13-1/2	
			16	15-1/4	15-1/2		
Timbers	5 & thicker	—	1/2 off	5 & wider	—	1/2 off	

**Table 1B Section Properties of Standard Dressed (S4S) Sawn Lumber**

Nominal Size b x d	Standard Dressed Size (S4S) b x d inches x inches	Area of Section A in. <sup>2</sup>	X-X Axis		Y-Y Axis		Approximate weight in pounds per linear foot (lb./ft.) of piece when density of wood equals:					
			Section Modulus S <sub>xx</sub> in. <sup>3</sup>	Moment of Inertia I <sub>xx</sub> in. <sup>4</sup>	Section Modulus S <sub>yy</sub> in. <sup>3</sup>	Moment of Inertia I <sub>yy</sub> in. <sup>4</sup>						
			25 lb./ft. <sup>3</sup>	30 lb./ft. <sup>3</sup>	35 lb./ft. <sup>3</sup>	40 lb./ft. <sup>3</sup>	45 lb./ft. <sup>3</sup>	50 lb./ft. <sup>3</sup>				
1 x 3	3/4 x 2-1/2	1.875	0.781	0.977	0.234	0.088	0.326	0.391	0.456	0.521	0.586	0.651
1 x 4	3/4 x 3-1/2	2.625	1.531	2.680	0.328	0.123	0.456	0.547	0.638	0.729	0.820	0.911
1 x 6	3/4 x 5-1/2	4.125	3.781	10.40	0.516	0.193	0.716	0.859	1.003	1.146	1.289	1.432
1 x 8	3/4 x 7-1/4	5.438	6.570	23.82	0.680	0.255	0.944	1.133	1.322	1.510	1.699	1.888
1 x 10	3/4 x 9-1/4	6.938	10.70	49.47	0.867	0.325	1.204	1.445	1.686	1.927	2.168	2.409
1 x 12	3/4 x 11-1/4	8.438	15.82	88.99	1.055	0.396	1.465	1.758	2.051	2.344	2.637	2.930
2 x 3	1-1/2 x 2-1/2	3.750	1.563	1.953	0.938	0.703	0.651	0.781	0.911	1.042	1.172	1.302
2 x 4	1-1/2 x 3-1/2	5.250	3.063	5.359	1.313	0.984	0.911	1.094	1.276	1.458	1.641	1.823
2 x 5	1-1/2 x 4-1/2	6.750	5.063	11.39	1.688	1.266	1.172	1.406	1.641	1.875	2.109	2.344
2 x 6	1-1/2 x 5-1/2	8.250	7.563	20.80	2.063	1.547	1.432	1.719	2.005	2.292	2.578	2.865
2 x 8	1-1/2 x 7-1/4	10.88	13.14	47.63	2.719	2.039	1.888	2.266	2.643	3.021	3.398	3.776
2 x 10	1-1/2 x 9-1/4	13.88	21.39	98.93	3.469	2.602	2.409	2.891	3.372	3.854	4.336	4.818
2 x 12	1-1/2 x 11-1/4	16.88	31.64	178.0	4.219	3.164	2.930	3.516	4.102	4.688	5.273	5.859
2 x 14	1-1/2 x 13-1/4	19.88	43.89	290.8	4.969	3.727	3.451	4.141	4.831	5.521	6.211	6.901
3 x 4	2-1/2 x 3-1/2	8.750	5.104	8.932	3.646	4.557	1.519	1.823	2.127	2.431	2.734	3.038
3 x 5	2-1/2 x 4-1/2	11.25	8.438	18.98	4.688	5.859	1.953	2.344	2.734	3.125	3.516	3.906
3 x 6	2-1/2 x 5-1/2	13.75	12.60	34.66	5.729	7.161	2.387	2.865	3.342	3.819	4.297	4.774
3 x 8	2-1/2 x 7-1/4	18.13	21.90	79.39	7.552	9.440	3.147	3.776	4.405	5.035	5.664	6.293
3 x 10	2-1/2 x 9-1/4	23.13	35.65	164.9	9.635	12.04	4.015	4.818	5.621	6.424	7.227	8.030
3 x 12	2-1/2 x 11-1/4	28.13	52.73	296.6	11.72	14.65	4.883	5.859	6.836	7.813	8.789	9.766
3 x 14	2-1/2 x 13-1/4	33.13	73.15	484.6	13.80	17.25	5.751	6.901	8.051	9.201	10.35	11.50
3 x 16	2-1/2 x 15-1/4	38.13	96.90	738.9	15.89	19.86	6.619	7.943	9.266	10.59	11.91	13.24
4 x 4	3-1/2 x 3-1/2	12.25	7.146	12.51	7.146	12.51	2.127	2.552	2.977	3.403	3.828	4.253
4 x 5	3-1/2 x 4-1/2	15.75	11.81	26.58	9.188	16.08	2.734	3.281	3.828	4.375	4.922	5.469
4 x 6	3-1/2 x 5-1/2	19.25	17.65	48.53	11.23	19.65	3.342	4.010	4.679	5.347	6.016	6.684
4 x 8	3-1/2 x 7-1/4	25.38	30.66	111.1	14.80	25.90	4.405	5.286	6.168	7.049	7.930	8.811
4 x 10	3-1/2 x 9-1/4	32.38	49.91	230.8	18.89	33.05	5.621	6.745	7.869	8.993	10.12	11.24
4 x 12	3-1/2 x 11-1/4	39.38	73.83	415.3	22.97	40.20	6.836	8.203	9.570	10.94	12.30	13.67
4 x 14	3-1/2 x 13-1/4	46.38	102.4	678.5	27.05	47.34	8.051	9.661	11.27	12.88	14.49	16.10
4 x 16	3-1/2 x 15-1/4	53.38	135.7	1034	31.14	54.49	9.266	11.12	12.97	14.83	16.68	18.53
5 x 5	4-1/2 x 4-1/2	20.25	15.19	34.17	15.19	34.17	3.516	4.219	4.922	5.625	6.328	7.031
6 x 6	5-1/2 x 5-1/2	30.25	27.73	76.26	27.73	76.26	5.252	6.302	7.352	8.403	9.453	10.50
6 x 8	5-1/2 x 7-1/2	41.25	51.56	193.4	37.81	104.0	7.161	8.594	10.03	11.46	12.89	14.32
6 x 10	5-1/2 x 9-1/2	52.25	82.73	393.0	47.90	131.7	9.071	10.89	12.70	14.51	16.33	18.14
6 x 12	5-1/2 x 11-1/2	63.25	121.2	697.1	57.98	159.4	10.98	13.18	15.37	17.57	19.77	21.96
6 x 14	5-1/2 x 13-1/2	74.25	167.1	1128	68.06	187.2	12.89	15.47	18.05	20.63	23.20	25.78
6 x 16	5-1/2 x 15-1/2	85.25	220.2	1707	78.15	214.9	14.80	17.76	20.72	23.68	26.64	29.60
6 x 18	5-1/2 x 17-1/2	96.25	280.7	2456	88.23	242.6	16.71	20.05	23.39	26.74	30.08	33.42
6 x 20	5-1/2 x 19-1/2	107.3	348.6	3398	98.31	270.4	18.62	22.34	26.07	29.79	33.52	37.24
6 x 22	5-1/2 x 21-1/2	118.3	423.7	4555	108.4	298.1	20.53	24.64	28.74	32.85	36.95	41.06
6 x 24	5-1/2 x 23-1/2	129.3	506.2	5948	118.5	325.8	22.44	26.93	31.41	35.90	40.39	44.88
8 x 8	7-1/2 x 7-1/2	56.25	70.31	263.7	70.31	263.7	9.766	11.72	13.67	15.63	17.58	19.53
8 x 10	7-1/2 x 9-1/2	71.25	112.8	535.9	89.06	334.0	12.37	14.84	17.32	19.79	22.27	24.74
8 x 12	7-1/2 x 11-1/2	86.25	165.3	950.5	107.8	404.3	14.97	17.97	20.96	23.96	26.95	29.95
8 x 14	7-1/2 x 13-1/2	101.3	227.8	1538	126.6	474.6	17.58	21.09	24.61	28.13	31.64	35.16
8 x 16	7-1/2 x 15-1/2	116.3	300.3	2327	145.3	544.9	20.18	24.22	28.26	32.29	36.33	40.36
8 x 18	7-1/2 x 17-1/2	131.3	382.8	3350	164.1	615.2	22.79	27.34	31.90	36.46	41.02	45.57
8 x 20	7-1/2 x 19-1/2	146.3	475.3	4634	182.8	685.5	25.39	30.47	35.55	40.63	45.70	50.78
8 x 22	7-1/2 x 21-1/2	161.3	577.8	6211	201.6	755.9	27.99	33.59	39.19	44.79	50.39	55.99
8 x 24	7-1/2 x 23-1/2	176.3	690.3	8111	220.3	826.2	30.60	36.72	42.84	48.96	55.08	61.20
10 x 10	9-1/2 x 9-1/2	90.25	142.9	678.8	142.9	678.8	15.67	18.80	21.94	25.07	28.20	31.34
10 x 12	9-1/2 x 11-1/2	109.3	209.4	1204	173.0	821.7	18.97	22.76	26.55	30.35	34.14	37.93
10 x 14	9-1/2 x 13-1/2	128.3	288.6	1948	203.1	964.5	22.27	26.72	31.17	35.63	40.08	44.53
10 x 16	9-1/2 x 15-1/2	147.3	380.4	2948	233.1	1107	25.56	30.68	35.79	40.90	46.02	51.13
10 x 18	9-1/2 x 17-1/2	166.3	484.9	4243	263.2	1250	28.86	34.64	40.41	46.18	51.95	57.73
10 x 20	9-1/2 x 19-1/2	185.3	602.1	5870	293.3	1393	32.16	38.59	45.03	51.46	57.89	64.32
10 x 22	9-1/2 x 21-1/2	204.3	731.9	7868	323.4	1536	35.46	42.55	49.64	56.74	63.83	70.92
10 x 24	9-1/2 x 23-1/2	223.3	874.4	10270	353.5	1679	38.76	46.51	54.26	62.01	69.77	77.52

**Table 1B Section Properties of Standard Dressed (S4S) Sawn Lumber (Cont.)**

Nominal Size b × d	Standard Dressed Size (S4S) b × d inches × inches	Area of Section A in. <sup>2</sup>	X-X Axis		Y-Y Axis		Approximate weight in pounds per linear foot (lb./ft.) of piece when density of wood equals:					
			Section Modulus S <sub>x</sub> in. <sup>3</sup>	Moment of Inertia I <sub>x</sub> in. <sup>4</sup>	Section Modulus S <sub>y</sub> in. <sup>3</sup>	Moment of Inertia I <sub>y</sub> in. <sup>4</sup>	25 lb./ft. <sup>3</sup>	30 lb./ft. <sup>3</sup>	35 lb./ft. <sup>3</sup>	40 lb./ft. <sup>3</sup>	45 lb./ft. <sup>3</sup>	50 lb./ft. <sup>3</sup>
12 × 12	11-1/2 × 11-1/2	132.3	253.5	1458	253.5	1458	22.96	27.55	32.14	36.74	41.33	45.92
12 × 14	11-1/2 × 13-1/2	155.3	349.3	2358	297.6	1711	26.95	32.34	37.73	43.13	48.52	53.91
12 × 16	11-1/2 × 15-1/2	178.3	460.5	3569	341.6	1964	30.95	37.14	43.32	49.51	55.70	61.89
12 × 18	11-1/2 × 17-1/2	201.3	587.0	5136	385.7	2218	34.94	41.93	48.91	55.90	62.89	69.88
12 × 20	11-1/2 × 19-1/2	224.3	728.8	7106	429.8	2471	38.93	46.72	54.51	62.29	70.08	77.86
12 × 22	11-1/2 × 21-1/2	247.3	886.0	9524	473.9	2725	42.93	51.51	60.10	68.68	77.27	85.85
12 × 24	11-1/2 × 23-1/2	270.3	1058	12440	518.0	2978	46.92	56.30	65.69	75.07	84.45	93.84
14 × 14	13-1/2 × 13-1/2	182.3	410.1	2768	410.1	2768	31.64	37.97	44.30	50.63	56.95	63.28
14 × 16	13-1/2 × 15-1/2	209.3	540.6	4189	470.8	3178	36.33	43.59	50.86	58.13	65.39	72.66
14 × 18	13-1/2 × 17-1/2	236.3	689.1	6029	531.6	3588	41.02	49.22	57.42	65.63	73.83	82.03
14 × 20	13-1/2 × 19-1/2	263.3	855.6	8342	592.3	3998	45.70	54.84	63.98	73.13	82.27	91.41
14 × 22	13-1/2 × 21-1/2	290.3	1040	11180	653.1	4408	50.39	60.47	70.55	80.63	90.70	100.8
14 × 24	13-1/2 × 23-1/2	317.3	1243	14600	713.8	4818	55.08	66.09	77.11	88.13	99.14	110.2
16 × 16	15-1/2 × 15-1/2	240.3	620.6	4810	620.6	4810	41.71	50.05	58.39	66.74	75.08	83.42
16 × 18	15-1/2 × 17-1/2	271.3	791.1	6923	700.7	5431	47.09	56.51	65.93	75.35	84.77	94.18
16 × 20	15-1/2 × 19-1/2	302.3	982.3	9578	780.8	6051	52.47	62.97	73.46	83.96	94.45	104.9
16 × 22	15-1/2 × 21-1/2	333.3	1194	12840	860.9	6672	57.86	69.43	81.00	92.57	104.1	115.7
16 × 24	15-1/2 × 23-1/2	364.3	1427	16760	941.0	7293	63.24	75.89	88.53	101.2	113.8	126.5
18 × 18	17-1/2 × 17-1/2	306.3	893.2	7816	893.2	7816	53.17	63.80	74.44	85.07	95.70	106.3
18 × 20	17-1/2 × 19-1/2	341.3	1109	10810	995.3	8709	59.24	71.09	82.94	94.79	106.6	118.5
18 × 22	17-1/2 × 21-1/2	376.3	1348	14490	1097	9602	65.32	78.39	91.45	104.5	117.6	130.6
18 × 24	17-1/2 × 23-1/2	411.3	1611	18930	1199	10500	71.40	85.68	99.96	114.2	128.5	142.8
20 × 20	19-1/2 × 19-1/2	380.3	1236	12050	1236	12050	66.02	79.22	92.42	105.6	118.8	132.0
20 × 22	19-1/2 × 21-1/2	419.3	1502	16150	1363	13280	72.79	87.34	101.9	116.5	131.0	145.6
20 × 24	19-1/2 × 23-1/2	458.3	1795	21090	1489	14520	79.56	95.47	111.4	127.3	143.2	159.1
22 × 22	21-1/2 × 21-1/2	462.3	1656	17810	1656	17810	80.25	96.30	112.4	128.4	144.5	160.5
22 × 24	21-1/2 × 23-1/2	505.3	1979	23250	1810	19460	87.72	105.3	122.8	140.3	157.9	175.4
24 × 24	23-1/2 × 23-1/2	552.3	2163	25420	2163	25420	95.88	115.1	134.2	153.4	172.6	191.8



**Table 1C Section Properties of Western Species Structural Glued Laminated Timber**

Depth	Area	X-X Axis			Y-Y Axis	
d (in.)	A (in. <sup>2</sup> )	I <sub>x</sub> (in. <sup>4</sup> )	S <sub>x</sub> (in. <sup>3</sup> )	r <sub>x</sub> (in.)	I <sub>y</sub> (in. <sup>4</sup> )	S <sub>y</sub> (in. <sup>3</sup> )
<b>2-1/2 in. Width</b>					<b>(r<sub>y</sub> = 0.722 in.)</b>	
6	15.00	45.00	15.00	1.732	7.813	6.250
7-1/2	18.75	87.89	23.44	2.165	9.766	7.813
9	22.50	151.9	33.75	2.598	11.72	9.375
10-1/2	26.25	241.2	45.94	3.031	13.67	10.94
12	30.00	360.0	60.00	3.464	15.63	12.50
13-1/2	33.75	512.6	75.94	3.897	17.58	14.06
15	37.50	703.1	93.75	4.330	19.53	15.63
16-1/2	41.25	935.9	113.4	4.763	21.48	17.19
18	45.00	1215	135.0	5.196	23.44	18.75
19-1/2	48.75	1545	158.4	5.629	25.39	20.31
21	52.50	1929	183.8	6.062	27.34	21.88
<b>3-1/8 in. Width</b>					<b>(r<sub>y</sub> = 0.902 in.)</b>	
6	18.75	56.25	18.75	1.732	15.26	9.766
7-1/2	23.44	109.9	29.30	2.165	19.07	12.21
9	28.13	189.8	42.19	2.598	22.89	14.65
10-1/2	32.81	301.5	57.42	3.031	26.70	17.09
12	37.50	450.0	75.00	3.464	30.52	19.53
13-1/2	42.19	640.7	94.92	3.897	34.33	21.97
15	46.88	878.9	117.2	4.330	38.15	24.41
16-1/2	51.56	1170	141.8	4.763	41.96	26.86
18	56.25	1519	168.8	5.196	45.78	29.30
19-1/2	60.94	1931	198.0	5.629	49.59	31.74
21	65.63	2412	229.7	6.062	53.41	34.18
22-1/2	70.31	2966	263.7	6.495	57.22	36.62
24	75.00	3600	300.0	6.928	61.04	39.06
<b>3-1/2 in. Width</b>					<b>(r<sub>y</sub> = 1.010 in.)</b>	
6	21.00	63.00	21.00	1.732	21.44	12.25
7-1/2	26.25	123.0	32.81	2.165	26.80	15.31
9	31.50	212.6	47.25	2.598	32.16	18.38
10-1/2	36.75	337.6	64.31	3.031	37.52	21.44
12	42.00	504.0	84.00	3.464	42.88	24.50
13-1/2	47.25	717.6	106.3	3.897	48.23	27.56
15	52.50	984.4	131.3	4.330	53.59	30.63
16-1/2	57.75	1310	158.8	4.763	58.95	33.69
18	63.00	1701	189.0	5.196	64.31	36.75
19-1/2	68.25	2163	221.8	5.629	69.67	39.81
21	73.50	2701	257.3	6.062	75.03	42.88
22-1/2	78.75	3322	295.3	6.495	80.39	45.94
24	84.00	4032	336.0	6.928	85.75	49.00

**Table 1C Section Properties of Western Species Structural Glued Laminated Timber (Cont.)**

Depth d (in.)	Area A (in. <sup>2</sup> )	X-X Axis			Y-Y Axis	
		I <sub>x</sub> (in. <sup>4</sup> )	S <sub>x</sub> (in. <sup>3</sup> )	r <sub>x</sub> (in.)	I <sub>y</sub> (in. <sup>4</sup> )	S <sub>y</sub> (in. <sup>3</sup> )
<b>5-1/8 in. Width</b>					<b>(r<sub>y</sub> = 1.479 in.)</b>	
6	30.75	92.25	30.75	1.732	67.31	26.27
7-1/2	38.44	180.2	48.05	2.165	84.13	32.83
9	46.13	311.3	69.19	2.598	101.0	39.40
10-1/2	53.81	494.4	94.17	3.031	117.8	45.96
12	61.50	738.0	123.0	3.464	134.6	52.53
13-1/2	69.19	1051	155.7	3.897	151.4	59.10
15	76.88	1441	192.2	4.330	168.3	65.66
16-1/2	84.56	1919	232.5	4.763	185.1	72.23
18	92.25	2491	276.8	5.196	201.9	78.80
19-1/2	99.94	3167	324.8	5.629	218.7	85.36
21	107.6	3955	376.7	6.062	235.6	91.93
22-1/2	115.3	4865	432.4	6.495	252.4	98.50
24	123.0	5904	492.0	6.928	269.2	105.1
25-1/2	130.7	7082	555.4	7.361	286.0	111.6
27	138.4	8406	622.7	7.794	302.9	118.2
28-1/2	146.1	9887	693.8	8.227	319.7	124.8
30	153.8	11530	768.8	8.660	336.5	131.3
31-1/2	161.4	13350	847.5	9.093	353.4	137.9
33	169.1	15350	930.2	9.526	370.2	144.5
34-1/2	176.8	17540	1017	9.959	387.0	151.0
36	184.5	19930	1107	10.39	403.8	157.6
<b>5-1/2 in. Width</b>					<b>(r<sub>y</sub> = 1.588 in.)</b>	
6	33.00	99.00	33.00	1.732	83.19	30.25
7-1/2	41.25	193.4	51.56	2.165	104.0	37.81
9	49.50	334.1	74.25	2.598	124.8	45.38
10-1/2	57.75	530.6	101.1	3.031	145.6	52.94
12	66.00	792.0	132.0	3.464	166.4	60.50
13-1/2	74.25	1128	167.1	3.897	187.2	68.06
15	82.50	1547	206.3	4.330	208.0	75.63
16-1/2	90.75	2059	249.6	4.763	228.8	83.19
18	99.00	2673	297.0	5.196	249.6	90.75
19-1/2	107.3	3398	348.6	5.629	270.4	98.31
21	115.5	4245	404.3	6.062	291.2	105.9
22-1/2	123.8	5221	464.1	6.495	312.0	113.4
24	132.0	6336	528.0	6.928	332.8	121.0
25-1/2	140.3	7600	596.1	7.361	353.5	128.6
27	148.5	9021	668.3	7.794	374.3	136.1
28-1/2	156.8	10610	744.6	8.227	395.1	143.7
30	165.0	12380	825.0	8.660	415.9	151.3
31-1/2	173.3	14330	909.6	9.093	436.7	158.8
33	181.5	16470	998.3	9.526	457.5	166.4
34-1/2	189.8	18820	1091	9.959	478.3	173.9
36	198.0	21380	1188	10.39	499.1	181.5

**Table 1C Section Properties of Western Species Structural Glued Laminated Timber (Cont.)**

Depth	Area	X-X Axis			Y-Y Axis	
d (in.)	A (in. <sup>2</sup> )	I <sub>x</sub> (in. <sup>4</sup> )	S <sub>x</sub> (in. <sup>3</sup> )	r <sub>x</sub> (in.)	I <sub>y</sub> (in. <sup>4</sup> )	S <sub>y</sub> (in. <sup>3</sup> )
<b>6-3/4 in. Width</b>				<b>(r<sub>y</sub> = 1.949 in.)</b>		
7-1/2	50.63	237.3	63.28	2.165	192.2	56.95
9	60.75	410.1	91.13	2.598	230.7	68.34
10-1/2	70.88	651.2	124.0	3.031	269.1	79.73
12	81.00	972.0	162.0	3.464	307.5	91.13
13-1/2	91.13	1384	205.0	3.897	346.0	102.5
15	101.3	1898	253.1	4.330	384.4	113.9
16-1/2	111.4	2527	306.3	4.763	422.9	125.3
18	121.5	3281	364.5	5.196	461.3	136.7
19-1/2	131.6	4171	427.8	5.629	499.8	148.1
21	141.8	5209	496.1	6.062	538.2	159.5
22-1/2	151.9	6407	569.5	6.495	576.7	170.9
24	162.0	7776	648.0	6.928	615.1	182.3
25-1/2	172.1	9327	731.5	7.361	653.5	193.6
27	182.3	11070	820.1	7.794	692.0	205.0
28-1/2	192.4	13020	913.8	8.227	730.4	216.4
30	202.5	15190	1013	8.660	768.9	227.8
31-1/2	212.6	17580	1116	9.093	807.3	239.2
33	222.8	20210	1225	9.526	845.8	250.6
34-1/2	232.9	23100	1339	9.959	884.2	262.0
36	243.0	26240	1458	10.39	922.6	273.4
37-1/2	253.1	29660	1582	10.83	961.1	284.8
39	263.3	33370	1711	11.26	999.5	296.2
40-1/2	273.4	37370	1845	11.69	1038	307.5
42	283.5	41670	1985	12.12	1076	318.9
43-1/2	293.6	46300	2129	12.56	1115	330.3
45	303.8	51260	2278	12.99	1153	341.7
46-1/2	313.9	56560	2433	13.42	1192	353.1
48	324.0	62210	2592	13.86	1230	364.5
49-1/2	334.1	68220	2757	14.29	1269	375.9
51	344.3	74620	2926	14.72	1307	387.3
52-1/2	354.4	81400	3101	15.16	1346	398.7
54	364.5	88570	3281	15.59	1384	410.1
55-1/2	374.6	96160	3465	16.02	1422	421.5
57	384.8	104200	3655	16.45	1461	432.8
58-1/2	394.9	112600	3850	16.89	1499	444.2
60	405.0	121500	4050	17.32	1538	455.6



**Table 1C Section Properties of Western Species Structural Glued Laminated Timber (Cont.)**

Depth d (in.)	Area A (in. <sup>2</sup> )	X-X Axis			Y-Y Axis	
		I <sub>x</sub> (in. <sup>4</sup> )	S <sub>x</sub> (in. <sup>3</sup> )	r <sub>x</sub> (in.)	I <sub>y</sub> (in. <sup>4</sup> )	S <sub>y</sub> (in. <sup>3</sup> )
<b>8-3/4 in. Width</b>				<b>(r<sub>y</sub> = 2.526 in.)</b>		
9	78.75	531.6	118.1	2.598	502.4	114.8
10-1/2	91.88	844.1	160.8	3.031	586.2	134.0
12	105.0	1260	210.0	3.464	669.9	153.1
13-1/2	118.1	1794	265.8	3.897	753.7	172.3
15	131.3	2461	328.1	4.330	837.4	191.4
16-1/2	144.4	3276	397.0	4.763	921.1	210.5
18	157.5	4253	472.5	5.196	1005	229.7
19-1/2	170.6	5407	554.5	5.629	1089	248.8
21	183.8	6753	643.1	6.062	1172	268.0
22-1/2	196.9	8306	738.3	6.495	1256	287.1
24	210.0	10080	840.0	6.928	1340	306.3
25-1/2	223.1	12090	948.3	7.361	1424	325.4
27	236.3	14350	1063	7.794	1507	344.5
28-1/2	249.4	16880	1185	8.227	1591	363.7
30	262.5	19690	1313	8.660	1675	382.8
31-1/2	275.6	22790	1447	9.093	1759	402.0
33	288.8	26200	1588	9.526	1842	421.1
34-1/2	301.9	29940	1736	9.959	1926	440.2
36	315.0	34020	1890	10.39	2010	459.4
37-1/2	328.1	38450	2051	10.83	2094	478.5
39	341.3	43250	2218	11.26	2177	497.7
40-1/2	354.4	48440	2392	11.69	2261	516.8
42	367.5	54020	2573	12.12	2345	535.9
43-1/2	380.6	60020	2760	12.56	2428	555.1
45	393.8	66450	2953	12.99	2512	574.2
46-1/2	406.9	73310	3153	13.42	2596	593.4
48	420.0	80640	3360	13.86	2680	612.5
49-1/2	433.1	88440	3573	14.29	2763	631.6
51	446.3	96720	3793	14.72	2847	650.8
52-1/2	459.4	105500	4020	15.16	2931	669.9
54	472.5	114800	4253	15.59	3015	689.1
55-1/2	485.6	124700	4492	16.02	3098	708.2
57	498.8	135000	4738	16.45	3182	727.3
58-1/2	511.9	146000	4991	16.89	3266	746.5
60	525.0	157500	5250	17.32	3350	765.6

**Table 1C Section Properties of Western Species Structural Glued Laminated Timber (Cont.)**

Depth	Area	X-X Axis			Y-Y Axis	
d (in.)	A (in. <sup>2</sup> )	I <sub>x</sub> (in. <sup>4</sup> )	S <sub>x</sub> (in. <sup>3</sup> )	r <sub>x</sub> (in.)	I <sub>y</sub> (in. <sup>4</sup> )	S <sub>y</sub> (in. <sup>3</sup> )
<b>10-3/4 in. Width</b>				<b>(r<sub>y</sub> = 3.103 in.)</b>		
12	129.0	1548	258.0	3.464	1242	231.1
13-1/2	145.1	2204	326.5	3.897	1398	260.0
15	161.3	3023	403.1	4.330	1553	288.9
16-1/2	177.4	4024	487.8	4.763	1708	317.8
18	193.5	5225	580.5	5.196	1863	346.7
19-1/2	209.6	6642	681.3	5.629	2019	375.6
21	225.8	8296	790.1	6.062	2174	404.5
22-1/2	241.9	10200	907.0	6.495	2329	433.4
24	258.0	12380	1032	6.928	2485	462.3
25-1/2	274.1	14850	1165	7.361	2640	491.1
27	290.3	17630	1306	7.794	2795	520.0
28-1/2	306.4	20740	1455	8.227	2950	548.9
30	322.5	24190	1613	8.660	3106	577.8
31-1/2	338.6	28000	1778	9.093	3261	606.7
33	354.8	32190	1951	9.526	3416	635.6
34-1/2	370.9	36790	2133	9.959	3572	664.5
36	387.0	41800	2322	10.39	3727	693.4
37-1/2	403.1	47240	2520	10.83	3882	722.3
39	419.3	53140	2725	11.26	4037	751.2
40-1/2	435.4	59510	2939	11.69	4193	780.0
42	451.5	66370	3161	12.12	4348	808.9
43-1/2	467.6	73740	3390	12.56	4503	837.8
45	483.8	81630	3628	12.99	4659	866.7
46-1/2	499.9	90070	3874	13.42	4814	895.6
48	516.0	99070	4128	13.86	4969	924.5
49-1/2	532.1	108700	4390	14.29	5124	953.4
51	548.3	118800	4660	14.72	5280	982.3
52-1/2	564.4	129600	4938	15.16	5435	1011
54	580.5	141100	5225	15.59	5590	1040
55-1/2	596.6	153100	5519	16.02	5746	1069
57	612.8	165900	5821	16.45	5901	1098
58-1/2	628.9	179300	6132	16.89	6056	1127
60	645.0	193500	6450	17.32	6211	1156

**Table 1C Section Properties of Western Species Structural Glued Laminated Timber (Cont.)**

Depth d (in.)	Area A (in. <sup>2</sup> )	X-X Axis			Y-Y Axis	
		I <sub>x</sub> (in. <sup>4</sup> )	S <sub>x</sub> (in. <sup>3</sup> )	r <sub>x</sub> (in.)	I <sub>y</sub> (in. <sup>4</sup> )	S <sub>y</sub> (in. <sup>3</sup> )
<b>12-1/4 in. Width</b>					<b>(r<sub>y</sub> = 3.536 in.)</b>	
13-1/2	165.4	2512	372.1	3.897	2068	337.6
15	183.8	3445	459.4	4.330	2298	375.2
16-1/2	202.1	4586	555.8	4.763	2528	412.7
18	220.5	5954	661.5	5.196	2757	450.2
19-1/2	238.9	7569	776.3	5.629	2987	487.7
21	257.3	9454	900.4	6.062	3217	525.2
22-1/2	275.6	11630	1034	6.495	3447	562.7
24	294.0	14110	1176	6.928	3677	600.3
25-1/2	312.4	16930	1328	7.361	3906	637.8
27	330.8	20090	1488	7.794	4136	675.3
28-1/2	349.1	23630	1658	8.227	4366	712.8
30	367.5	27560	1838	8.660	4596	750.3
31-1/2	385.9	31910	2026	9.093	4825	787.8
33	404.3	36690	2223	9.526	5055	825.3
34-1/2	422.6	41920	2430	9.959	5285	862.9
36	441.0	47630	2646	10.39	5515	900.4
37-1/2	459.4	53830	2871	10.83	5745	937.9
39	477.8	60550	3105	11.26	5974	975.4
40-1/2	496.1	67810	3349	11.69	6204	1013
42	514.5	75630	3602	12.12	6434	1050
43-1/2	532.9	84030	3863	12.56	6664	1088
45	551.3	93020	4134	12.99	6893	1125
46-1/2	569.6	102600	4415	13.42	7123	1163
48	588.0	112900	4704	13.86	7353	1201
49-1/2	606.4	123800	5003	14.29	7583	1238
51	624.8	135400	5310	14.72	7813	1276
52-1/2	643.1	147700	5627	15.16	8042	1313
54	661.5	160700	5954	15.59	8272	1351
55-1/2	679.9	174500	6289	16.02	8502	1388
57	698.3	189100	6633	16.45	8732	1426
58-1/2	716.6	204400	6987	16.89	8962	1463
60	735.0	220500	7350	17.32	9191	1501

**Table 1D Section Properties of Southern Pine Structural Glued Laminated Timber**

Depth d (in.)	Area A (in. <sup>2</sup> )	X-X Axis			Y-Y Axis	
		I <sub>x</sub> (in. <sup>4</sup> )	S <sub>x</sub> (in. <sup>3</sup> )	r <sub>x</sub> (in.)	I <sub>y</sub> (in. <sup>4</sup> )	S <sub>y</sub> (in. <sup>3</sup> )
<b>2-1/2 in. Width</b>					<b>(r<sub>y</sub> = 0.722 in.)</b>	
5-1/2	13.75	34.66	12.60	1.588	7.161	5.729
6-7/8	17.19	67.70	19.69	1.985	8.952	7.161
8-1/4	20.63	117.0	28.36	2.382	10.74	8.594
9-5/8	24.06	185.8	38.60	2.778	12.53	10.03
11	27.50	277.3	50.42	3.175	14.32	11.46
12-3/8	30.94	394.8	63.81	3.572	16.11	12.89
13-3/4	34.38	541.6	78.78	3.969	17.90	14.32
15-1/8	37.81	720.9	95.32	4.366	19.69	15.76
16-1/2	41.25	935.9	113.4	4.763	21.48	17.19
17-7/8	44.69	1190	133.1	5.160	23.27	18.62
19-1/4	48.13	1486	154.4	5.557	25.07	20.05
20-5/8	51.56	1828	177.2	5.954	26.86	21.48
22	55.00	2218	201.7	6.351	28.65	22.92
23-3/8	58.44	2661	227.7	6.748	30.44	24.35
<b>3 in. Width</b>					<b>(r<sub>y</sub> = 0.866 in.)</b>	
5-1/2	16.50	41.59	15.13	1.588	12.38	8.250
6-7/8	20.63	81.24	23.63	1.985	15.47	10.31
8-1/4	24.75	140.4	34.03	2.382	18.56	12.38
9-5/8	28.88	222.9	46.32	2.778	21.66	14.44
11	33.00	332.8	60.50	3.175	24.75	16.50
12-3/8	37.13	473.8	76.57	3.572	27.84	18.56
13-3/4	41.25	649.9	94.53	3.969	30.94	20.63
15-1/8	45.38	865.0	114.4	4.366	34.03	22.69
16-1/2	49.50	1123	136.1	4.763	37.13	24.75
17-7/8	53.63	1428	159.8	5.160	40.22	26.81
19-1/4	57.75	1783	185.3	5.557	43.31	28.88
20-5/8	61.88	2193	212.7	5.954	46.41	30.94
22	66.00	2662	242.0	6.351	49.50	33.00
23-3/8	70.13	3193	273.2	6.748	52.59	35.06
<b>3-1/8 in. Width</b>					<b>(r<sub>y</sub> = 0.902 in.)</b>	
5-1/2	17.19	43.33	15.76	1.588	13.99	8.952
6-7/8	21.48	84.62	24.62	1.985	17.48	11.19
8-1/4	25.78	146.2	35.45	2.382	20.98	13.43
9-5/8	30.08	232.2	48.25	2.778	24.48	15.67
11	34.38	346.6	63.02	3.175	27.97	17.90
12-3/8	38.67	493.5	79.76	3.572	31.47	20.14
13-3/4	42.97	677.0	98.47	3.969	34.97	22.38
15-1/8	47.27	901.1	119.1	4.366	38.46	24.62
16-1/2	51.56	1170	141.8	4.763	41.96	26.86
17-7/8	55.86	1487	166.4	5.160	45.46	29.09
19-1/4	60.16	1858	193.0	5.557	48.96	31.33
20-5/8	64.45	2285	221.6	5.954	52.45	33.57
22	68.75	2773	252.1	6.351	55.95	35.81
23-3/8	73.05	3326	284.6	6.748	59.45	38.05

**Table 1D Section Properties of Southern Pine Structural Glued Laminated Timber (Cont.)**

Depth d (in.)	Area A (in. <sup>2</sup> )	X-X Axis			Y-Y Axis	
		I <sub>x</sub> (in. <sup>4</sup> )	S <sub>x</sub> (in. <sup>3</sup> )	r <sub>x</sub> (in.)	I <sub>y</sub> (in. <sup>4</sup> )	S <sub>y</sub> (in. <sup>3</sup> )
<b>3-1/2 in. Width</b>					<b>(r<sub>y</sub> = 1.010 in.)</b>	
5-1/2	19.25	48.53	17.65	1.588	19.65	11.23
6-7/8	24.06	94.78	27.57	1.985	24.56	14.04
8-1/4	28.88	163.8	39.70	2.382	29.48	16.84
9-5/8	33.69	260.1	54.04	2.778	34.39	19.65
11	38.50	388.2	70.58	3.175	39.30	22.46
12-3/8	43.31	552.7	89.33	3.572	44.21	25.27
13-3/4	48.13	758.2	110.3	3.969	49.13	28.07
15-1/8	52.94	1009	133.4	4.366	54.04	30.88
16-1/2	57.75	1310	158.8	4.763	58.95	33.69
17-7/8	62.56	1666	186.4	5.160	63.87	36.49
19-1/4	67.38	2081	216.2	5.557	68.78	39.30
20-5/8	72.19	2559	248.1	5.954	73.69	42.11
22	77.00	3106	282.3	6.351	78.60	44.92
23-3/8	81.81	3725	318.7	6.748	83.52	47.72
<b>5 in. Width</b>					<b>(r<sub>y</sub> = 1.443 in.)</b>	
6-7/8	34.38	135.4	39.39	1.985	71.61	28.65
8-1/4	41.25	234.0	56.72	2.382	85.94	34.38
9-5/8	48.13	371.5	77.20	2.778	100.3	40.10
11	55.00	554.6	100.8	3.175	114.6	45.83
12-3/8	61.88	789.6	127.6	3.572	128.9	51.56
13-3/4	68.75	1083	157.6	3.969	143.2	57.29
15-1/8	75.63	1442	190.6	4.366	157.6	63.02
16-1/2	82.50	1872	226.9	4.763	171.9	68.75
17-7/8	89.38	2380	266.3	5.160	186.2	74.48
19-1/4	96.25	2972	308.8	5.557	200.5	80.21
20-5/8	103.1	3656	354.5	5.954	214.8	85.94
22	110.0	4437	403.3	6.351	229.2	91.67
23-3/8	116.9	5322	455.3	6.748	243.5	97.40
24-3/4	123.8	6317	510.5	7.145	257.8	103.1
26-1/8	130.6	7429	568.8	7.542	272.1	108.9
27-1/2	137.5	8665	630.2	7.939	286.5	114.6
28-7/8	144.4	10030	694.8	8.335	300.8	120.3
30-1/4	151.3	11530	762.6	8.732	315.1	126.0
31-5/8	158.1	13180	833.5	9.129	329.4	131.8
33	165.0	14970	907.5	9.526	343.8	137.5
34-3/8	171.9	16920	984.7	9.923	358.1	143.2
35-3/4	178.8	19040	1065	10.32	372.4	149.0

**Table 1D Section Properties of Southern Pine Structural Glued Laminated Timber (Cont.)**

Depth d (in.)	Area A (in. <sup>2</sup> )	X-X Axis			Y-Y Axis	
		I <sub>x</sub> (in. <sup>4</sup> )	S <sub>x</sub> (in. <sup>3</sup> )	r <sub>x</sub> (in.)	I <sub>y</sub> (in. <sup>4</sup> )	S <sub>y</sub> (in. <sup>3</sup> )
<b>5-1/8 in. Width</b>					<b>(r<sub>y</sub> = 1.479 in.)</b>	
6-7/8	35.23	138.8	40.37	1.985	77.12	30.10
8-1/4	42.28	239.8	58.14	2.382	92.55	36.12
9-5/8	49.33	380.8	79.13	2.778	108.0	42.13
11	56.38	568.4	103.4	3.175	123.4	48.15
12-3/8	63.42	809.4	130.8	3.572	138.8	54.17
13-3/4	70.47	1110	161.5	3.969	154.2	60.19
15-1/8	77.52	1478	195.4	4.366	169.7	66.21
16-1/2	84.56	1919	232.5	4.763	185.1	72.23
17-7/8	91.61	2439	272.9	5.160	200.5	78.25
19-1/4	98.66	3047	316.5	5.557	215.9	84.27
20-5/8	105.7	3747	363.4	5.954	231.4	90.29
22	112.8	4548	413.4	6.351	246.8	96.31
23-3/8	119.8	5455	466.7	6.748	262.2	102.3
24-3/4	126.8	6475	523.2	7.145	277.6	108.3
26-1/8	133.9	7615	583.0	7.542	293.1	114.4
27-1/2	140.9	8882	646	7.939	308.5	120.4
28-7/8	148.0	10280	712.2	8.335	323.9	126.4
30-1/4	155.0	11820	781.6	8.732	339.3	132.4
31-5/8	162.1	13510	854.3	9.129	354.8	138.4
33	169.1	15350	930.2	9.526	370.2	144.5
34-3/8	176.2	17350	1009	9.923	385.6	150.5
35-3/4	183.2	19510	1092	10.32	401.0	156.5
<b>5-1/2 in. Width</b>					<b>(r<sub>y</sub> = 1.588 in.)</b>	
6-7/8	37.81	148.9	43.33	1.985	95.32	34.66
8-1/4	45.38	257.4	62.39	2.382	114.4	41.59
9-5/8	52.94	408.7	84.92	2.778	133.4	48.53
11	60.50	610.0	110.9	3.175	152.5	55.46
12-3/8	68.06	868.6	140.4	3.572	171.6	62.39
13-3/4	75.63	1191	173.3	3.969	190.6	69.32
15-1/8	83.19	1586	209.7	4.366	209.7	76.26
16-1/2	90.75	2059	249.6	4.763	228.8	83.19
17-7/8	98.31	2618	292.9	5.160	247.8	90.12
19-1/4	105.9	3269	339.7	5.557	266.9	97.05
20-5/8	113.4	4021	389.9	5.954	286.0	104.0
22	121.0	4880	443.7	6.351	305.0	110.9
23-3/8	128.6	5854	500.9	6.748	324.1	117.8
24-3/4	136.1	6949	561.5	7.145	343.1	124.8
26-1/8	143.7	8172	625.6	7.542	362.2	131.7
27-1/2	151.3	9532	693.2	7.939	381.3	138.6
28-7/8	158.8	11030	764.3	8.335	400.3	145.6
30-1/4	166.4	12690	838.8	8.732	419.4	152.5
31-5/8	173.9	14500	916.8	9.129	438.5	159.4
33	181.5	16470	998.3	9.526	457.5	166.4
34-3/8	189.1	18620	1083	9.923	476.6	173.3
35-3/4	196.6	20940	1172	10.32	495.7	180.2

**Table 1D Section Properties of Southern Pine Structural Glued Laminated Timber (Cont.)**

Depth d (in.)	Area A (in. <sup>2</sup> )	X-X Axis			Y-Y Axis	
		I <sub>x</sub> (in. <sup>4</sup> )	S <sub>x</sub> (in. <sup>3</sup> )	r <sub>x</sub> (in.)	I <sub>y</sub> (in. <sup>4</sup> )	S <sub>y</sub> (in. <sup>3</sup> )
<b>6-3/4 in. Width</b>					<b>(r<sub>y</sub> = 1.949 in.)</b>	
6-7/8	46.41	182.8	53.17	1.985	176.2	52.21
8-1/4	55.69	315.9	76.57	2.382	211.4	62.65
9-5/8	64.97	501.6	104.2	2.778	246.7	73.09
11	74.25	748.7	136.1	3.175	281.9	83.53
12-3/8	83.53	1066	172.3	3.572	317.2	93.97
13-3/4	92.81	1462	212.7	3.969	352.4	104.4
15-1/8	102.1	1946	257.4	4.366	387.6	114.9
16-1/2	111.4	2527	306.3	4.763	422.9	125.3
17-7/8	120.7	3213	359.5	5.160	458.1	135.7
19-1/4	129.9	4012	416.9	5.557	493.4	146.2
20-5/8	139.2	4935	478.6	5.954	528.6	156.6
22	148.5	5990	544.5	6.351	563.8	167.1
23-3/8	157.8	7184	614.7	6.748	599.1	177.5
24-3/4	167.1	8528	689.1	7.145	634.3	187.9
26-1/8	176.3	10030	767.8	7.542	669.6	198.4
27-1/2	185.6	11700	850.8	7.939	704.8	208.8
28-7/8	194.9	13540	938.0	8.335	740.0	219.3
30-1/4	204.2	15570	1029	8.732	775.3	229.7
31-5/8	213.5	17790	1125	9.129	810.5	240.2
33	222.8	20210	1225	9.526	845.8	250.6
34-3/8	232.0	22850	1329	9.923	881.0	261.0
35-3/4	241.3	25700	1438	10.32	916.2	271.5
37-1/8	250.6	28780	1551	10.72	951.5	281.9
38-1/2	259.9	32100	1668	11.11	986.7	292.4
39-7/8	269.2	35660	1789	11.51	1022	302.8
41-1/4	278.4	39480	1914	11.91	1057	313.2
42-5/8	287.7	43560	2044	12.30	1092	323.7
44	297.0	47920	2178	12.70	1128	334.1
45-3/8	306.3	52550	2316	13.10	1163	344.6
46-3/4	315.6	57470	2459	13.50	1198	355.0
48-1/8	324.8	62700	2606	13.89	1233	365.4
49-1/2	334.1	68220	2757	14.29	1269	375.9
50-7/8	343.4	74070	2912	14.69	1304	386.3
52-1/4	352.7	80240	3071	15.08	1339	396.8
53-5/8	362.0	86740	3235	15.48	1374	407.2
55	371.3	93590	3403	15.88	1410	417.7
56-3/8	380.5	100800	3575	16.27	1445	428.1
57-3/4	389.8	108300	3752	16.67	1480	438.5
59-1/8	399.1	116300	3933	17.07	1515	449.0
60-1/2	408.4	124600	4118	17.46	1551	459.4

**SECTION PROPERTIES**

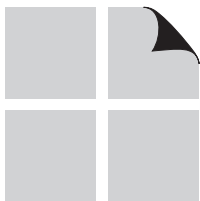
**Table 1D Section Properties of Southern Pine Structural Glued Laminated Timber (Cont.)**

Depth d (in.)	Area A (in. <sup>2</sup> )	X-X Axis			Y-Y Axis	
		I <sub>x</sub> (in. <sup>4</sup> )	S <sub>x</sub> (in. <sup>3</sup> )	r <sub>x</sub> (in.)	I <sub>y</sub> (in. <sup>4</sup> )	S <sub>y</sub> (in. <sup>3</sup> )
<b>8-1/2 in. Width</b>					<b>(r<sub>y</sub> = 2.454 in.)</b>	
9-5/8	81.81	631.6	131.2	2.778	492.6	115.9
11	93.50	942.8	171.4	3.175	562.9	132.5
12-3/8	105.2	1342	216.9	3.572	633.3	149.0
13-3/4	116.9	1841	267.8	3.969	703.7	165.6
15-1/8	128.6	2451	324.1	4.366	774.1	182.1
16-1/2	140.3	3182	385.7	4.763	844.4	198.7
17-7/8	151.9	4046	452.6	5.160	914.8	215.2
19-1/4	163.6	5053	525.0	5.557	985.2	231.8
20-5/8	175.3	6215	602.6	5.954	1056	248.4
22	187.0	7542	685.7	6.351	1126	264.9
23-3/8	198.7	9047	774.1	6.748	1196	281.5
24-3/4	210.4	10740	867.8	7.145	1267	298.0
26-1/8	222.1	12630	966.9	7.542	1337	314.6
27-1/2	233.8	14730	1071	7.939	1407	331.1
28-7/8	245.4	17050	1181	8.335	1478	347.7
30-1/4	257.1	19610	1296	8.732	1548	364.3
31-5/8	268.8	22400	1417	9.129	1618	380.8
33	280.5	25460	1543	9.526	1689	397.4
34-3/8	292.2	28770	1674	9.923	1759	413.9
35-3/4	303.9	32360	1811	10.32	1830	430.5
37-1/8	315.6	36240	1953	10.72	1900	447.0
38-1/2	327.3	40420	2100	11.11	1970	463.6
39-7/8	338.9	44910	2253	11.51	2041	480.2
41-1/4	350.6	49720	2411	11.91	2111	496.7
42-5/8	362.3	54860	2574	12.30	2181	513.3
44	374.0	60340	2743	12.70	2252	529.8
45-3/8	385.7	66170	2917	13.10	2322	546.4
46-3/4	397.4	72370	3096	13.50	2393	562.9
48-1/8	409.1	78950	3281	13.89	2463	579.5
49-1/2	420.8	85910	3471	14.29	2533	596.1
50-7/8	432.4	93270	3667	14.69	2604	612.6
52-1/4	444.1	101000	3868	15.08	2674	629.2
53-5/8	455.8	109200	4074	15.48	2744	645.7
55	467.5	117800	4285	15.88	2815	662.3
56-3/8	479.2	126900	4502	16.27	2885	678.8
57-3/4	490.9	136400	4725	16.67	2955	695.4
59-1/8	502.6	146400	4952	17.07	3026	712.0
60-1/2	514.3	156900	5185	17.46	3096	728.5



**Table 1D Section Properties of Southern Pine Structural Glued Laminated Timber (Cont.)**

Depth	Area	X-X Axis			Y-Y Axis	
d (in.)	A (in. <sup>2</sup> )	I <sub>x</sub> (in. <sup>4</sup> )	S <sub>x</sub> (in. <sup>3</sup> )	r <sub>x</sub> (in.)	I <sub>y</sub> (in. <sup>4</sup> )	S <sub>y</sub> (in. <sup>3</sup> )
<b>10-1/2 in. Width</b>				<b>(r<sub>y</sub> = 3.031 in.)</b>		
11	115.5	1165	211.8	3.175	1061	202.1
12-3/8	129.9	1658	268.0	3.572	1194	227.4
13-3/4	144.4	2275	330.9	3.969	1326	252.7
15-1/8	158.8	3028	400.3	4.366	1459	277.9
16-1/2	173.3	3931	476.4	4.763	1592	303.2
17-7/8	187.7	4997	559.2	5.160	1724	328.5
19-1/4	202.1	6242	648.5	5.557	1857	353.7
20-5/8	216.6	7677	744.4	5.954	1990	379.0
22	231.0	9317	847.0	6.351	2122	404.3
23-3/8	245.4	11180	956.2	6.748	2255	429.5
24-3/4	259.9	13270	1072	7.145	2388	454.8
26-1/8	274.3	15600	1194	7.542	2520	480.0
27-1/2	288.8	18200	1323	7.939	2653	505.3
28-7/8	303.2	21070	1459	8.335	2786	530.6
30-1/4	317.6	24220	1601	8.732	2918	555.8
31-5/8	332.1	27680	1750	9.129	3051	581.1
33	346.5	31440	1906	9.526	3183	606.4
34-3/8	360.9	35540	2068	9.923	3316	631.6
35-3/4	375.4	39980	2237	10.32	3449	656.9
37-1/8	389.8	44770	2412	10.72	3581	682.2
38-1/2	404.3	49930	2594	11.11	3714	707.4
39-7/8	418.7	55480	2783	11.51	3847	732.7
41-1/4	433.1	61420	2978	11.91	3979	758.0
42-5/8	447.6	67760	3180	12.30	4112	783.2
44	462.0	74540	3388	12.70	4245	808.5
45-3/8	476.4	81740	3603	13.10	4377	833.8
46-3/4	490.9	89400	3825	13.50	4510	859.0
48-1/8	505.3	97530	4053	13.89	4643	884.3
49-1/2	519.8	106100	4288	14.29	4775	909.6
50-7/8	534.2	115200	4529	14.69	4908	934.8
52-1/4	548.6	124800	4778	15.08	5040	960.1
53-5/8	563.1	134900	5032	15.48	5173	985.4
55	577.5	145600	5294	15.88	5306	1011
56-3/8	591.9	156800	5562	16.27	5438	1036
57-3/4	606.4	168500	5836	16.67	5571	1061
59-1/8	620.8	180900	6118	17.07	5704	1086
60-1/2	635.3	193800	6405	17.46	5836	1112

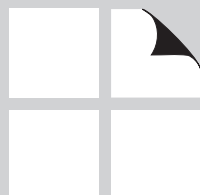


# REFERENCE DESIGN VALUES

4

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Table 4A	Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick).....	s30
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**Table 4A Adjustment Factors****Repetitive Member Factor,  $C_r$** 

Bending design values,  $F_b$ , for dimension lumber 2" to 4" thick shall be multiplied by the repetitive member factor,  $C_r = 1.15$ , when such members are used as joists, truss chords, rafters, studs, planks, decking, or similar members which are in contact or spaced not more than 24" on center, are not less than 3 in number and are joined by floor, roof, or other load distributing elements adequate to support the design load.

**Wet Service Factor,  $C_M$** 

When dimension lumber is used where moisture content will exceed 19% for an extended time period, design values shall be multiplied by the appropriate wet service factors from the following table:

**Wet Service Factors,  $C_M$** 

$F_b$	$F_t$	$F_v$	$F_{c\perp}$	$F_c$	E and $E_{min}$
0.85*	1.0	0.97	0.67	0.8**	0.9

\* when  $(F_b)(C_F) \leq 1,150$  psi,  $C_M = 1.0$

\*\* when  $(F_c)(C_F) \leq 750$  psi,  $C_M = 1.0$

**Flat Use Factor,  $C_{fu}$** 

Bending design values adjusted by size factors are based on edgewise use (load applied to narrow face). When dimension lumber is used flatwise (load applied to wide face), the bending design value,  $F_b$ , shall also be multiplied by the following flat use factors:

**Flat Use Factors,  $C_{fu}$** 

Width (depth)	Thickness (breadth)	
	2" & 3"	4"
2" & 3"	1.0	—
4"	1.1	1.0
5"	1.1	1.05
6"	1.15	1.05
8"	1.15	1.05
10" & wider	1.2	1.1

**NOTE**

To facilitate the use of Table 4A, shading has been employed to distinguish design values based on a 4" nominal width (Construction, Standard, and Utility grades) or a 6" nominal width (Stud grade) from design values based on a 12" nominal width (Select Structural, No.1 & Btr, No.1, No.2, and No.3 grades).

**Size Factor,  $C_F$** 

Tabulated bending, tension, and compression parallel to grain design values for dimension lumber 2" to 4" thick shall be multiplied by the following size factors:

**Size Factors,  $C_F$** 

Grades	Width (depth)	$F_b$		$F_t$	$F_c$
		Thickness (breadth)			
		2" & 3"	4"		
Select Structural, No.1 & Btr, No.1, No.2, No.3	2", 3", & 4"	1.5	1.5	1.5	1.15
	5"	1.4	1.4	1.4	1.1
	6"	1.3	1.3	1.3	1.1
	8"	1.2	1.3	1.2	1.05
	10"	1.1	1.2	1.1	1.0
	12"	1.0	1.1	1.0	1.0
	14" & wider	0.9	1.0	0.9	0.9
Stud	2", 3", & 4"	1.1	1.1	1.1	1.05
	5" & 6"	1.0	1.0	1.0	1.0
	8" & wider	Use No.3 Grade tabulated design values and size factors			
Construction, Standard	2", 3", & 4"	1.0	1.0	1.0	1.0
Utility	4"	1.0	1.0	1.0	1.0
	2" & 3"	0.4	—	0.4	0.6

only to be used with the 2005 NDS® and Wood Structural Design Data

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REFERENCE DESIGN VALUES

**Table 4A Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)<sup>1,2,3</sup>**

(All species except Southern Pine — see Table 4B) (Tabulated design values are for normal load duration and dry service conditions. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

USE WITH TABLE 4A ADJUSTMENT FACTORS

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{cL}$	Compression parallel to grain $F_c$	Modulus of Elasticity		
							E	$E_{min}$	
<b>ALASKA CEDAR</b>									
Select Structural		1,150	625	165	525	1,000	1,400,000	510,000	WCLIB
No.1	2" & wider	975	525	165	525	900	1,300,000	470,000	
No.2		800	425	165	525	750	1,200,000	440,000	
No.3		450	250	165	525	425	1,100,000	400,000	
Stud	2" & wider	625	350	165	525	475	1,100,000	400,000	
Construction	2" - 4" wide	900	500	165	525	950	1,200,000	440,000	
Standard		500	275	165	525	775	1,100,000	400,000	
Utility		250	125	165	525	500	1,000,000	370,000	
<b>ALASKA HEMLOCK</b>									
Select Structural		1,300	825	185	440	1,200	1,700,000	620,000	WWPA
No.1	2" & wider	900	550	185	440	1,100	1,600,000	580,000	
No.2		825	475	185	440	1,050	1,500,000	550,000	
No.3		475	275	185	440	600	1,400,000	510,000	
Stud	2" & wider	650	375	185	440	650	1,400,000	510,000	
Construction	2" - 4" wide	950	550	185	440	1,250	1,400,000	510,000	
Standard		525	300	185	440	1,050	1,300,000	470,000	
Utility		250	150	185	440	700	1,200,000	440,000	
<b>ALASKA SPRUCE</b>									
Select Structural		1,400	900	160	330	1,200	1,600,000	580,000	WWPA
No.1	2" & wider	950	600	160	330	1,100	1,500,000	550,000	
No.2		875	500	160	330	1,050	1,400,000	510,000	
No.3		500	300	160	330	600	1,300,000	470,000	
Stud	2" & wider	675	400	160	330	675	1,300,000	470,000	
Construction	2" - 4" wide	1,000	575	160	330	1,250	1,300,000	470,000	
Standard		550	325	160	330	1,050	1,200,000	440,000	
Utility		275	150	160	330	700	1,100,000	400,000	
<b>ALASKA YELLOW CEDAR</b>									
Select Structural		1,350	800	225	510	1,200	1,500,000	550,000	WCLIB WWPA
No.1	2" & wider	900	525	225	510	1,050	1,400,000	510,000	
No.2		800	450	225	510	1,000	1,300,000	470,000	
No.3		475	250	225	510	575	1,200,000	440,000	
Stud	2" & wider	625	350	225	510	625	1,200,000	440,000	
Construction	2" - 4" wide	925	500	225	510	1,250	1,300,000	470,000	
Standard		500	275	225	510	1,050	1,100,000	400,000	
Utility		250	125	225	510	675	1,100,000	400,000	
<b>ASPEN</b>									
Select Structural		875	500	120	265	725	1,100,000	400,000	NELMA NSLB WWPA
No.1	2" & wider	625	375	120	265	600	1,100,000	400,000	
No.2		600	350	120	265	450	1,000,000	370,000	
No.3		350	200	120	265	275	900,000	330,000	
Stud	2" & wider	475	275	120	265	300	900,000	330,000	
Construction	2" - 4" wide	700	400	120	265	625	900,000	330,000	
Standard		375	225	120	265	475	900,000	330,000	
Utility		175	100	120	265	300	800,000	290,000	
<b>BALDCYPRESS</b>									
Select Structural		1,200	650	160	615	1,200	1,400,000	510,000	SPIB
No.1	2" & wider	1,000	550	160	615	1,050	1,400,000	510,000	
No.2		825	450	160	615	900	1,300,000	470,000	
No.3		475	250	160	615	525	1,200,000	440,000	
Stud	2" & wider	650	350	160	615	575	1,200,000	440,000	
Construction	2" - 4" wide	925	500	160	615	1,100	1,200,000	440,000	
Standard		525	275	160	615	925	1,100,000	400,000	
Utility		250	125	160	615	600	1,000,000	370,000	

**Table 4A Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)<sup>1,2,3</sup>**

(All species except Southern Pine — see Table 4B) (Tabulated design values are for normal load duration and dry service conditions. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

USE WITH TABLE 4A ADJUSTMENT FACTORS

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{cL}$	Compression parallel to grain $F_c$	Modulus of Elasticity		
							E	$E_{min}$	
<b>BEECH-BIRCH-HICKORY</b>									
Select Structural		1,450	850	195	715	1,200	1,700,000	620,000	NELMA
No.1	2" & wider	1,050	600	195	715	950	1,600,000	580,000	
No.2		1,000	600	195	715	750	1,500,000	550,000	
No.3		575	350	195	715	425	1,300,000	470,000	
Stud	2" & wider	775	450	195	715	475	1,300,000	470,000	
Construction	2" - 4" wide	1,150	675	195	715	1,000	1,400,000	510,000	
Standard		650	375	195	715	775	1,300,000	470,000	
Utility		300	175	195	715	500	1,200,000	440,000	
<b>COTTONWOOD</b>									
Select Structural		875	525	125	320	775	1,200,000	440,000	NSLB
No.1	2" & wider	625	375	125	320	625	1,200,000	440,000	
No.2		625	350	125	320	475	1,100,000	400,000	
No.3		350	200	125	320	275	1,000,000	370,000	
Stud	2" & wider	475	275	125	320	300	1,000,000	370,000	
Construction	2" - 4" wide	700	400	125	320	650	1,000,000	370,000	
Standard		400	225	125	320	500	900,000	330,000	
Utility		175	100	125	320	325	900,000	330,000	
<b>DOUGLAS FIR-LARCH</b>									
Select Structural		1,500	1,000	180	625	1,700	1,900,000	690,000	WCLIB WWPA
No.1 & Btr	2" & wider	1,200	800	180	625	1,550	1,800,000	660,000	
No.1		1,000	675	180	625	1,500	1,700,000	620,000	
No.2		900	575	180	625	1,350	1,600,000	580,000	
No.3	525	325	180	625	775	1,400,000	510,000		
Stud	2" & wider	700	450	180	625	850	1,400,000	510,000	
Construction	2" - 4" wide	1,000	650	180	625	1,650	1,500,000	550,000	
Standard		575	375	180	625	1,400	1,400,000	510,000	
Utility		275	175	180	625	900	1,300,000	470,000	
<b>DOUGLAS FIR-LARCH (NORTH)</b>									
Select Structural		1,350	825	180	625	1,900	1,900,000	690,000	NLGA
No.1 & Btr	2" & wider	1,150	750	180	625	1,800	1,800,000	660,000	
No.1/No.2		850	500	180	625	1,400	1,600,000	580,000	
No.3		475	300	180	625	825	1,400,000	510,000	
Stud	2" & wider	650	400	180	625	900	1,400,000	510,000	
Construction	2" - 4" wide	950	575	180	625	1,800	1,500,000	550,000	
Standard		525	325	180	625	1,450	1,400,000	510,000	
Utility		250	150	180	625	950	1,300,000	470,000	
<b>DOUGLAS FIR-SOUTH</b>									
Select Structural		1,350	900	180	520	1,600	1,400,000	510,000	WWPA
No.1	2" & wider	925	600	180	520	1,450	1,300,000	470,000	
No.2		850	525	180	520	1,350	1,200,000	440,000	
No.3		500	300	180	520	775	1,100,000	400,000	
Stud	2" & wider	675	425	180	520	850	1,100,000	400,000	
Construction	2" - 4" wide	975	600	180	520	1,650	1,200,000	440,000	
Standard		550	350	180	520	1,400	1,100,000	400,000	
Utility		250	150	180	520	900	1,000,000	370,000	
<b>EASTERN HEMLOCK-BALSAM FIR</b>									
Select Structural		1,250	575	140	335	1,200	1,200,000	440,000	NELMA NSLB
No.1	2" & wider	775	350	140	335	1,000	1,100,000	400,000	
No.2		575	275	140	335	825	1,100,000	400,000	
No.3		350	150	140	335	475	900,000	330,000	
Stud	2" & wider	450	200	140	335	525	900,000	330,000	
Construction	2" - 4" wide	675	300	140	335	1,050	1,000,000	370,000	
Standard		375	175	140	335	850	900,000	330,000	
Utility		175	75	140	335	550	800,000	290,000	

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**Table 4A Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)<sup>1,2,3</sup>**

(All species except Southern Pine — see Table 4B) (Tabulated design values are for normal load duration and dry service conditions. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

USE WITH TABLE 4A ADJUSTMENT FACTORS

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{c\perp}$	Compression parallel to grain $F_c$	Modulus of Elasticity		
							E	$E_{min}$	
<b>EASTERN HEMLOCK-TAMARACK</b>									
Select Structural		1,250	575	170	555	1,200	1,200,000	440,000	NELMA NSLB
No.1	2" & wider	775	350	170	555	1,000	1,100,000	400,000	
No.2		575	275	170	555	825	1,100,000	400,000	
No.3		350	150	170	555	475	900,000	330,000	
Stud	2" & wider	450	200	170	555	525	900,000	330,000	
Construction	2" - 4" wide	675	300	170	555	1,050	1,000,000	370,000	
Standard		375	175	170	555	850	900,000	330,000	
Utility		175	75	170	555	550	800,000	290,000	
<b>EASTERN SOFTWOODS</b>									
Select Structural		1,250	575	140	335	1,200	1,200,000	440,000	NELMA NSLB
No.1	2" & wider	775	350	140	335	1,000	1,100,000	400,000	
No.2		575	275	140	335	825	1,100,000	400,000	
No.3		350	150	140	335	475	900,000	330,000	
Stud	2" & wider	450	200	140	335	525	900,000	330,000	
Construction	2" - 4" wide	675	300	140	335	1,050	1,000,000	370,000	
Standard		375	175	140	335	850	900,000	330,000	
Utility		175	75	140	335	550	800,000	290,000	
<b>EASTERN WHITE PINE</b>									
Select Structural		1,250	575	135	350	1,200	1,200,000	440,000	NELMA NSLB
No.1	2" & wider	775	350	135	350	1,000	1,100,000	400,000	
No.2		575	275	135	350	825	1,100,000	400,000	
No.3		350	150	135	350	475	900,000	330,000	
Stud	2" & wider	450	200	135	350	525	900,000	330,000	
Construction	2" - 4" wide	675	300	135	350	1,050	1,000,000	370,000	
Standard		375	175	135	350	850	900,000	330,000	
Utility		175	75	135	350	550	800,000	290,000	
<b>HEM-FIR</b>									
Select Structural		1,400	925	150	405	1,500	1,600,000	580,000	WCLIB WWPA
No.1 & Btr	2" & wider	1,100	725	150	405	1,350	1,500,000	550,000	
No.1		975	625	150	405	1,350	1,500,000	550,000	
No.2		850	525	150	405	1,300	1,300,000	470,000	
No.3	500	300	150	405	725	1,200,000	440,000		
Stud	2" & wider	675	400	150	405	800	1,200,000	440,000	
Construction	2" - 4" wide	975	600	150	405	1,550	1,300,000	470,000	
Standard		550	325	150	405	1,300	1,200,000	440,000	
Utility		250	150	150	405	850	1,100,000	400,000	
<b>HEM-FIR (NORTH)</b>									
Select Structural		1,300	775	145	405	1,700	1,700,000	620,000	NLGA
No.1 & Btr	2" & wider	1,200	725	145	405	1,550	1,700,000	620,000	
No.1/No.2		1,000	575	145	405	1,450	1,600,000	580,000	
No.3		575	325	145	405	850	1,400,000	510,000	
Stud	2" & wider	775	450	145	405	925	1,400,000	510,000	
Construction	2" - 4" wide	1,150	650	145	405	1,750	1,500,000	550,000	
Standard		650	350	145	405	1,500	1,400,000	510,000	
Utility		300	175	145	405	975	1,300,000	470,000	
<b>MIXED MAPLE</b>									
Select Structural		1,000	600	195	620	875	1,300,000	470,000	NELMA
No.1	2" & wider	725	425	195	620	700	1,200,000	440,000	
No.2		700	425	195	620	550	1,100,000	400,000	
No.3		400	250	195	620	325	1,000,000	370,000	
Stud	2" & wider	550	325	195	620	350	1,000,000	370,000	
Construction	2" - 4" wide	800	475	195	620	725	1,100,000	400,000	
Standard		450	275	195	620	575	1,000,000	370,000	
Utility		225	125	195	620	375	900,000	330,000	

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4

REFERENCE DESIGN VALUES

**Table 4A Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)<sup>1,2,3</sup>**

(All species except Southern Pine — see Table 4B) (Tabulated design values are for normal load duration and dry service conditions. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

USE WITH TABLE 4A ADJUSTMENT FACTORS

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{c\perp}$	Compression parallel to grain $F_c$	Modulus of Elasticity		
							E	$E_{min}$	
<b>MIXED OAK</b>									
Select Structural No.1	2" & wider	1,150	675	170	800	1,000	1,100,000	400,000	NELMA
No.2		825	500	170	800	825	1,000,000	370,000	
No.3		800	475	170	800	625	900,000	330,000	
Stud		475	275	170	800	375	800,000	290,000	
Construction Standard		625	375	170	800	400	800,000	290,000	
Utility	2" - 4" wide	925	550	170	800	850	900,000	330,000	
		525	300	170	800	650	800,000	290,000	
		250	150	170	800	425	800,000	290,000	
<b>NORTHERN RED OAK</b>									
Select Structural No.1	2" & wider	1,400	800	220	885	1,150	1,400,000	510,000	NELMA
No.2		1,000	575	220	885	925	1,400,000	510,000	
No.3		975	575	220	885	725	1,300,000	470,000	
Stud		550	325	220	885	425	1,200,000	440,000	
Construction Standard		750	450	220	885	450	1,200,000	440,000	
Utility	2" - 4" wide	1,100	650	220	885	975	1,200,000	440,000	
		625	350	220	885	750	1,100,000	400,000	
		300	175	220	885	500	1,000,000	370,000	
<b>NORTHERN SPECIES</b>									
Select Structural No.1/No.2	2" & wider	1,000	450	110	350	1,100	1,100,000	400,000	NLGA
No.3		600	275	110	350	850	1,100,000	400,000	
Stud		350	150	110	350	500	1,000,000	370,000	
Construction Standard		475	225	110	350	550	1,000,000	370,000	
Utility		2" - 4" wide	700	300	110	350	1,050	1,000,000	
		400	175	110	350	875	900,000	330,000	
		175	75	110	350	575	900,000	330,000	
<b>NORTHERN WHITE CEDAR</b>									
Select Structural No.1	2" & wider	775	450	120	370	750	800,000	290,000	NELMA
No.2		575	325	120	370	600	700,000	260,000	
No.3		550	325	120	370	475	700,000	260,000	
Stud		325	175	120	370	275	600,000	220,000	
Construction Standard		425	250	120	370	300	600,000	220,000	
Utility	2" - 4" wide	625	375	120	370	625	700,000	260,000	
		350	200	120	370	475	600,000	220,000	
		175	100	120	370	325	600,000	220,000	
<b>RED MAPLE</b>									
Select Structural No.1	2" & wider	1,300	750	210	615	1,100	1,700,000	620,000	NELMA
No.2		925	550	210	615	900	1,600,000	580,000	
No.3		900	525	210	615	700	1,500,000	550,000	
Stud		525	300	210	615	400	1,300,000	470,000	
Construction Standard		700	425	210	615	450	1,300,000	470,000	
Utility	2" - 4" wide	1,050	600	210	615	925	1,400,000	510,000	
		575	325	210	615	725	1,300,000	470,000	
		275	150	210	615	475	1,200,000	440,000	
<b>RED OAK</b>									
Select Structural No.1	2" & wider	1,150	675	170	820	1,000	1,400,000	510,000	NELMA
No.2		825	500	170	820	825	1,300,000	470,000	
No.3		800	475	170	820	625	1,200,000	440,000	
Stud		475	275	170	820	375	1,100,000	400,000	
Construction Standard		625	375	170	820	400	1,100,000	400,000	
Utility	2" - 4" wide	925	550	170	820	850	1,200,000	440,000	
		525	300	170	820	650	1,100,000	400,000	
		250	150	170	820	425	1,000,000	370,000	

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**Table 4A Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)<sup>1,2,3</sup>**

(All species except Southern Pine — see Table 4B) (Tabulated design values are for normal load duration and dry service conditions. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

USE WITH TABLE 4A ADJUSTMENT FACTORS

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{cL}$	Compression parallel to grain $F_c$	Modulus of Elasticity		
							E	$E_{min}$	
<b>REDWOOD</b>									
Clear Structural	2" & wider	1,750	1,000	160	650	1,850	1,400,000	510,000	RIS
Select Structural		1,350	800	160	650	1,500	1,400,000	510,000	
Select Structural, open grain		1,100	625	160	425	1,100	1,100,000	400,000	
No.1		975	575	160	650	1,200	1,300,000	470,000	
No.1, open grain		775	450	160	425	900	1,100,000	400,000	
No.2		925	525	160	650	950	1,200,000	440,000	
No.2, open grain		725	425	160	425	700	1,000,000	370,000	
No.3		525	300	160	650	550	1,100,000	400,000	
No.3, open grain		425	250	160	425	400	900,000	330,000	
Stud		575	325	160	425	450	900,000	330,000	
Construction	2" - 4" wide	825	475	160	425	925	900,000	330,000	
Standard		450	275	160	425	725	900,000	330,000	
Utility		225	125	160	425	475	800,000	290,000	
<b>SPRUCE-PINE-FIR</b>									
Select Structural	2" & wider	1,250	700	135	425	1,400	1,500,000	550,000	NLGA
No.1/No.2		875	450	135	425	1,150	1,400,000	510,000	
No.3		500	250	135	425	650	1,200,000	440,000	
Stud		675	350	135	425	725	1,200,000	440,000	
Construction	1,000	500	135	425	1,400	1,300,000	470,000		
Standard	550	275	135	425	1,150	1,200,000	440,000		
Utility	275	125	135	425	750	1,100,000	400,000		
<b>SPRUCE-PINE-FIR (SOUTH)</b>									
Select Structural	2" & wider	1,300	575	135	335	1,200	1,300,000	470,000	NELMA NSLB WCLIB WWPA
No.1		875	400	135	335	1,050	1,200,000	440,000	
No.2		775	350	135	335	1,000	1,100,000	400,000	
No.3		450	200	135	335	575	1,000,000	370,000	
Stud		600	275	135	335	625	1,000,000	370,000	
Construction		875	400	135	335	1,200	1,000,000	370,000	
Standard	500	225	135	335	1,000	900,000	330,000		
Utility	225	100	135	335	675	900,000	330,000		
<b>WESTERN CEDARS</b>									
Select Structural	2" & wider	1,000	600	155	425	1,000	1,100,000	400,000	WCLIB WWPA
No.1		725	425	155	425	825	1,000,000	370,000	
No.2		700	425	155	425	650	1,000,000	370,000	
No.3		400	250	155	425	375	900,000	330,000	
Stud		550	325	155	425	400	900,000	330,000	
Construction		800	475	155	425	850	900,000	330,000	
Standard	450	275	155	425	650	800,000	290,000		
Utility	225	125	155	425	425	800,000	290,000		
<b>WESTERN WOODS</b>									
Select Structural	2" & wider	900	400	135	335	1,050	1,200,000	440,000	WCLIB WWPA
No.1		675	300	135	335	950	1,100,000	400,000	
No.2		675	300	135	335	900	1,000,000	370,000	
No.3		375	175	135	335	525	900,000	330,000	
Stud		525	225	135	335	575	900,000	330,000	
Construction		775	350	135	335	1,100	1,000,000	370,000	
Standard	425	200	135	335	925	900,000	330,000		
Utility	200	100	135	335	600	800,000	290,000		

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**Table 4A Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)<sup>1,2,3</sup>**  
**(Cont.)**

(All species except Southern Pine — see Table 4B) (Tabulated design values are for normal load duration and dry service conditions. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

USE WITH TABLE 4A ADJUSTMENT FACTORS

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{c\perp}$	Compression parallel to grain $F_c$	Modulus of Elasticity		
							E	$E_{min}$	
<b>WHITE OAK</b>									
Select Structural	2" & wider	1,200	700	220	800	1,100	1,100,000	400,000	NELMA
No.1		875	500	220	800	900	1,000,000	370,000	
No.2		850	500	220	800	700	900,000	330,000	
No.3		475	275	220	800	400	800,000	290,000	
Stud		650	375	220	800	450	800,000	290,000	
Construction Standard		950	550	220	800	925	900,000	330,000	
Utility	2" - 4" wide	525	325	220	800	725	800,000	290,000	
Utility		250	150	220	800	475	800,000	290,000	
<b>YELLOW POPLAR</b>									
Select Structural	2" & wider	1,000	575	145	420	900	1,500,000	550,000	NSLB
No.1		725	425	145	420	725	1,400,000	510,000	
No.2		700	400	145	420	575	1,300,000	470,000	
No.3		400	225	145	420	325	1,200,000	440,000	
Stud		550	325	145	420	350	1,200,000	440,000	
Construction Standard		800	475	145	420	750	1,300,000	470,000	
Utility	2" - 4" wide	450	250	145	420	575	1,100,000	400,000	
Utility		200	125	145	420	375	1,100,000	400,000	

- LUMBER DIMENSIONS.** Tabulated design values are applicable to lumber that will be used under dry conditions such as in most covered structures. For 2" to 4" thick lumber the DRY dressed sizes shall be used (see Table 1A) regardless of the moisture content at the time of manufacture or use. In calculating design values, the natural gain in strength and stiffness that occurs as lumber dries has been taken into consideration as well as the reduction in size that occurs when unseasoned lumber shrinks. The gain in load carrying capacity due to increased strength and stiffness resulting from drying more than offsets the design effect of size reductions due to shrinkage.
- STRESS-RATED BOARDS.** Stress-rated boards of nominal 1", 1-1/4" and 1-1/2" thickness, 2" and wider, of most species, are permitted to use the design values shown for Select Structural, No.1 & Btr, No.1, No.2, No.3, Stud, Construction, Standard, Utility, and Clear Structural grades as shown in the 2" to 4" thick categories herein, when graded in accordance with the stress-rated board provisions in the applicable grading rules. Information on stress-rated board grades applicable to the various species is available from the respective grading rules agencies. Information on additional design values may also be available from the respective grading rules agencies.
- When individual species or species groups are combined, the design values to be used for the combination shall be the lowest design values for each individual species or species group for each design property.

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**Table 4B Adjustment Factors****Size Factor,  $C_F$** 

Appropriate size adjustment factors have already been incorporated in the tabulated design values for most thicknesses of Southern Pine and Mixed Southern Pine dimension lumber. For dimension lumber 4" thick, 8" and wider (all grades except Dense Structural 86, Dense Structural 72, and Dense Structural 65), tabulated bending design values,  $F_b$ , shall be permitted to be multiplied by the size factor,  $C_F = 1.1$ . For dimension lumber wider than 12" (all grades except Dense Structural 86, Dense Structural 72, and Dense Structural 65), tabulated bending, tension and compression parallel to grain design values for 12" wide lumber shall be multiplied by the size factor,  $C_F = 0.9$ . When the depth,  $d$ , of Dense Structural 86, Dense Structural 72, or Dense Structural 65 dimension lumber exceeds 12", the tabulated bending design value,  $F_b$ , shall be multiplied by the following size factor:

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

**Repetitive Member Factor,  $C_r$** 

Bending design values,  $F_b$ , for dimension lumber 2" to 4" thick shall be multiplied by the repetitive member factor,  $C_r = 1.15$ , when such members are used as joists, truss chords, rafters, studs, planks, decking, or similar members which are in contact or spaced not more than 24" on center, are not less than 3 in number and are joined by floor, roof, or other load distributing elements adequate to support the design load.

**Flat Use Factor,  $C_{fu}$** 

Bending design values adjusted by size factors are based on edgewise use (load applied to narrow face). When dimension lumber is used flatwise (load applied to wide face), the bending design value,  $F_b$ , shall also be multiplied by the following flat use factors:

**Flat Use Factors,  $C_{fu}$** 

Width (depth)	Thickness (breadth)	
	2" & 3"	4"
2" & 3"	1.0	—
4"	1.1	1.0
5"	1.1	1.05
6"	1.15	1.05
8"	1.15	1.05
10" & wider	1.2	1.1

**Wet Service Factor,  $C_M$** 

When dimension lumber is used where moisture content will exceed 19% for an extended time period, design values shall be multiplied by the appropriate wet service factors from the following table (for surfaced dry Dense Structural 86, Dense Structural 72, and Dense Structural 65 use tabulated surfaced green design values for wet service conditions without further adjustment):

**Wet Service Factors,  $C_M$** 

$F_b$	$F_t$	$F_v$	$F_{c\perp}$	$F_c$	E and $E_{min}$
0.85*	1.0	0.97	0.67	0.8**	0.9

\* when  $(F_b)(C_F) \leq 1,150$  psi,  $C_M = 1.0$

\*\* when  $(F_c) \leq 750$  psi,  $C_M = 1.0$

**Table 4B Reference Design Values for Visually Graded Southern Pine Dimension Lumber (2" - 4" thick)<sup>1,2,3,4,5</sup>**

(Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4B ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{cL}$	Compression parallel to grain $F_c$	Modulus of Elasticity		
							E	$E_{min}$	
<b>SOUTHERN PINE</b>									
Dense Select Structural	2" - 4" wide	3,050	1,650	175	660	2,250	1,900,000	690,000	SPIB
Select Structural		2,850	1,600	175	565	2,100	1,800,000	660,000	
Non-Dense Select Structural		2,650	1,350	175	480	1,950	1,700,000	620,000	
No.1 Dense		2,000	1,100	175	660	2,000	1,800,000	660,000	
No.1		1,850	1,050	175	565	1,850	1,700,000	620,000	
No.1 Non-Dense		1,700	900	175	480	1,700	1,600,000	580,000	
No.2 Dense		1,700	875	175	660	1,850	1,700,000	620,000	
No.2		1,500	825	175	565	1,650	1,600,000	580,000	
No.2 Non-Dense		1,350	775	175	480	1,600	1,400,000	510,000	
No.3 and Stud		850	475	175	565	975	1,400,000	510,000	
Construction Standard	4" wide	1,100	625	175	565	1,800	1,500,000	550,000	SPIB
Utility		625	350	175	565	1,500	1,300,000	470,000	
		300	175	175	565	975	1,300,000	470,000	
Dense Select Structural	5" - 6" wide	2,700	1,500	175	660	2,150	1,900,000	690,000	
Select Structural		2,550	1,400	175	565	2,000	1,800,000	660,000	
Non-Dense Select Structural		2,350	1,200	175	480	1,850	1,700,000	620,000	
No.1 Dense		1,750	950	175	660	1,900	1,800,000	660,000	
No.1		1,650	900	175	565	1,750	1,700,000	620,000	
No.1 Non-Dense		1,500	800	175	480	1,600	1,600,000	580,000	
No.2 Dense		1,450	775	175	660	1,750	1,700,000	620,000	
No.2		1,250	725	175	565	1,600	1,600,000	580,000	
No.2 Non-Dense		1,150	675	175	480	1,500	1,400,000	510,000	
No.3 and Stud		750	425	175	565	925	1,400,000	510,000	
Dense Select Structural	8" wide	2,450	1,350	175	660	2,050	1,900,000	690,000	SPIB
Select Structural		2,300	1,300	175	565	1,900	1,800,000	660,000	
Non-Dense Select Structural		2,100	1,100	175	480	1,750	1,700,000	620,000	
No.1 Dense		1,650	875	175	660	1,800	1,800,000	660,000	
No.1		1,500	825	175	565	1,650	1,700,000	620,000	
No.1 Non-Dense		1,350	725	175	480	1,550	1,600,000	580,000	
No.2 Dense		1,400	675	175	660	1,700	1,700,000	620,000	
No.2		1,200	650	175	565	1,550	1,600,000	580,000	
No.2 Non-Dense		1,100	600	175	480	1,450	1,400,000	510,000	
No.3 and Stud		700	400	175	565	875	1,400,000	510,000	
Dense Select Structural	10" wide	2,150	1,200	175	660	2,000	1,900,000	690,000	SPIB
Select Structural		2,050	1,100	175	565	1,850	1,800,000	660,000	
Non-Dense Select Structural		1,850	950	175	480	1,750	1,700,000	620,000	
No.1 Dense		1,450	775	175	660	1,750	1,800,000	660,000	
No.1		1,300	725	175	565	1,600	1,700,000	620,000	
No.1 Non-Dense		1,200	650	175	480	1,500	1,600,000	580,000	
No.2 Dense		1,200	625	175	660	1,650	1,700,000	620,000	
No.2		1,050	575	175	565	1,500	1,600,000	580,000	
No.2 Non-Dense		950	550	175	480	1,400	1,400,000	510,000	
No.3 and Stud		600	325	175	565	850	1,400,000	510,000	
Dense Select Structural	12" wide	2,050	1,100	175	660	1,950	1,900,000	690,000	SPIB
Select Structural		1,900	1,050	175	565	1,800	1,800,000	660,000	
Non-Dense Select Structural		1,750	900	175	480	1,700	1,700,000	620,000	
No.1 Dense		1,350	725	175	660	1,700	1,800,000	660,000	
No.1		1,250	675	175	565	1,600	1,700,000	620,000	
No.1 Non-Dense		1,150	600	175	480	1,500	1,600,000	580,000	
No.2 Dense		1,150	575	175	660	1,600	1,700,000	620,000	
No.2		975	550	175	565	1,450	1,600,000	580,000	
No.2 Non-Dense		900	525	175	480	1,350	1,400,000	510,000	
No.3 and Stud		575	325	175	565	825	1,400,000	510,000	

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4 REFERENCE DESIGN VALUES

**Table 4B Reference Design Values for Visually Graded Southern Pine Dimension Lumber (2" - 4" thick)<sup>1,2,3,4,5</sup>**

(Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4B ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{c\perp}$	Compression parallel to grain $F_c$	Modulus of Elasticity		
							E	$E_{min}$	
<b>SOUTHERN PINE (Surfaced Dry - Used in dry service conditions - 19% or less moisture content)</b>									
Dense Structural 86	2" & wider	2,600	1,750	175	660	2,000	1,800,000	660,000	SPIB
Dense Structural 72		2,200	1,450	175	660	1,650	1,800,000	660,000	
Dense Structural 65		2,000	1,300	175	660	1,500	1,800,000	660,000	
<b>SOUTHERN PINE (Surfaced Green - Used in any service condition)</b>									
Dense Structural 86	2-1/2" & wider 2-1/2"-4" thick	2,100	1,400	165	440	1,300	1,600,000	580,000	SPIB
Dense Structural 72		1,750	1,200	165	440	1,100	1,600,000	580,000	
Dense Structural 65		1,600	1,050	165	440	1,000	1,600,000	580,000	
<b>MIXED SOUTHERN PINE</b>									
Select Structural No.1	2" - 4" wide	2,050	1,200	175	565	1,800	1,600,000	580,000	SPIB
No.2		1,450	875	175	565	1,650	1,500,000	550,000	
No.3 and Stud		1,300	775	175	565	1,650	1,400,000	510,000	
Construction Standard Utility	4" wide	750	450	175	565	950	1,200,000	440,000	
		1,000	600	175	565	1,700	1,300,000	470,000	
		550	325	175	565	1,450	1,200,000	440,000	
		275	150	175	565	950	1,100,000	400,000	
Select Structural No.1	5" - 6" wide	1,850	1,100	175	565	1,700	1,600,000	580,000	
No.2		1,300	750	175	565	1,550	1,500,000	550,000	
No.3 and Stud		1,150	675	175	565	1,550	1,400,000	510,000	
		675	400	175	565	875	1,200,000	440,000	
Select Structural No.1	8" wide	1,750	1,000	175	565	1,600	1,600,000	580,000	
No.2		1,200	700	175	565	1,450	1,500,000	550,000	
No.3 and Stud		1,050	625	175	565	1,450	1,400,000	510,000	
		625	375	175	565	850	1,200,000	440,000	
Select Structural No.1	10" wide	1,500	875	175	565	1,600	1,600,000	580,000	
No.2		1,050	600	175	565	1,450	1,500,000	550,000	
No.3 and Stud		925	550	175	565	1,450	1,400,000	510,000	
		525	325	175	565	825	1,200,000	440,000	
Select Structural No.1	12" wide	1,400	825	175	565	1,550	1,600,000	580,000	
No.2		975	575	175	565	1,400	1,500,000	550,000	
No.3 and Stud		875	525	175	565	1,400	1,400,000	510,000	
		500	300	175	565	800	1,200,000	440,000	

- LUMBER DIMENSIONS.** Tabulated design values are applicable to lumber that will be used under dry conditions such as in most covered structures. For 2" to 4" thick lumber the DRY dressed sizes shall be used (see Table 1A) regardless of the moisture content at the time of manufacture or use. In calculating design values, the natural gain in strength and stiffness that occurs as lumber dries has been taken into consideration as well as the reduction in size that occurs when unseasoned lumber shrinks. The gain in load carrying capacity due to increased strength and stiffness resulting from drying more than offsets the design effect of size reductions due to shrinkage.
- STRESS-RATED BOARDS.** Information for various grades of Southern Pine stress-rated boards of nominal 1", 1-1/4", and 1-1/2" thickness, 2" and wider is available from the Southern Pine Inspection Bureau (SPIB) in the *Standard Grading Rules for Southern Pine Lumber*.
- SPRUCE PINE.** To obtain recommended design values for Spruce Pine graded to SPIB rules, multiply the appropriate design values for Mixed Southern Pine by the corresponding conversion factor shown below and round to the nearest 100,000 psi for E; to the nearest 10,000 psi for  $E_{min}$ ; to the next lower multiple of 5 psi for  $F_v$  and  $F_{c\perp}$ ; to the next lower multiple of 50 psi for  $F_b$ ,  $F_t$ , and  $F_c$  if 1,000 psi or greater, 25 psi otherwise.

**CONVERSION FACTORS FOR DETERMINING DESIGN VALUES FOR SPRUCE PINE**

Conversion Factor	Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{c\perp}$	Compression parallel to grain $F_c$	Modulus of Elasticity E and $E_{min}$
	0.78	0.78	0.98	0.73	0.78	0.82

- SIZE FACTOR.** For sizes wider than 12", use size factors for  $F_b$ ,  $F_t$ , and  $F_c$  specified for the 12" width. Use 100% of the  $F_v$ ,  $F_{c\perp}$ , E, and  $E_{min}$  specified for the 12" width.
- When individual species or species groups are combined, the design values to be used for the combination shall be the lowest design values for each individual species or species group for each design property.

## Table 4C Adjustment Factors

### Flat Use Factor, $C_{fu}$

Bending design values adjusted by size factors are based on edgewise use (load applied to narrow face). When dimension lumber is used flatwise (load applied to wide face), the bending design value,  $F_b$ , shall also be multiplied by the following flat use factors:

Flat Use Factors,  $C_{fu}$

Width (depth)	Thickness (breadth)
	2"
2" & 3"	1.0
4"	1.1
5"	1.1
6"	1.15
8"	1.15
10" & wider	1.2

### Repetitive Member Factor, $C_r$

Bending design values,  $F_b$ , for dimension lumber 2" to 4" thick shall be multiplied by the repetitive member factor,  $C_r = 1.15$ , when such members are used as joists, truss chords, rafters, studs, planks, decking, or similar members which are in contact or spaced not more than 24" on center, are not less than 3 in number and are joined by floor, roof, or other load distributing elements adequate to support the design load.

### Wet Service Factor, $C_M$

When dimension lumber is used where moisture content will exceed 19% for an extended time period, design values shall be multiplied by the appropriate wet service factors from the following table:

Wet Service Factors,  $C_M$

$F_b$	$F_t$	$F_v$	$F_{c\perp}$	$F_c$	E and $E_{min}$
0.85*	1.0	0.97	0.67	0.8**	0.9

\* when  $F_b \leq 1,150$  psi,  $C_M = 1.0$

\*\* when  $F_c \leq 750$  psi,  $C_M = 1.0$

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REFERENCE DESIGN VALUES

**Table 4C Reference Design Values for Mechanically Graded Dimension Lumber<sup>1,2,3</sup>**  
 (Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

USE WITH TABLE 4C ADJUSTMENT FACTORS

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)					Grading Rules Agency
		Bending F <sub>b</sub>	Tension parallel to grain F <sub>t</sub>	Compression parallel to grain F <sub>c</sub>	Modulus of Elasticity		
					E	E <sub>min</sub>	
<b>MACHINE STRESS RATED (MSR) LUMBER</b>							
900f-1.0E	2" and less in thickness  2" and wider	900	350	1,050	1,000,000	510,000	WCLIB, WWPA, NELMA, NSLB
1200f-1.2E		1,200	600	1,400	1,200,000	610,000	NLGA, WCLIB, WWPA, NELMA, NSLB
1250f-1.4E		1,250	800	1,475	1,400,000	710,000	WCLIB, WWPA
1350f-1.3E		1,350	750	1,600	1,300,000	660,000	NLGA, WCLIB, WWPA, NELMA, NSLB
1400f-1.2E		1,400	800	1,600	1,200,000	610,000	NLGA, WWPA
1450f-1.3E		1,450	800	1,625	1,300,000	660,000	NLGA, WCLIB, WWPA, NELMA, NSLB
1450f-1.5E		1,450	875	1,625	1,500,000	760,000	WCLIB, WWPA
1500f-1.4E		1,500	900	1,650	1,400,000	710,000	NLGA, WCLIB, WWPA, NELMA, NSLB
1600f-1.4E		1,600	950	1,675	1,400,000	710,000	NLGA, WWPA
1650f-1.3E		1,650	1,020	1,700	1,300,000	660,000	NLGA, WWPA
1650f-1.5E		1,650	1,020	1,700	1,500,000	760,000	NLGA, SPIB, WCLIB, WWPA, NELMA, NSLB
1650f-1.6E-1075f <sub>t</sub>		1,650	1,075	1,700	1,600,000	810,000	WCLIB, WWPA
1650f-1.6E		1,650	1,175	1,700	1,600,000	810,000	WCLIB, WWPA
1650f-1.8E		1,650	1,020	1,750	1,800,000	910,000	WCLIB, WWPA
1700f-1.6E		1,700	1,175	1,725	1,600,000	810,000	WCLIB, WWPA
1750f-2.0E		1,750	1,125	1,725	2,000,000	1,020,000	WCLIB, WWPA
1800f-1.5E		1,800	1,300	1,750	1,500,000	760,000	NLGA, WWPA
1800f-1.6E		1,800	1,175	1,750	1,600,000	810,000	NLGA, SPIB, WCLIB, WWPA, NELMA, NSLB
1800f-1.8E		1,800	1,200	1,750	1,800,000	910,000	WCLIB, WWPA
1950f-1.5E		1,950	1,375	1,800	1,500,000	760,000	SPIB, WWPA
1950f-1.7E		1,950	1,375	1,800	1,700,000	860,000	NLGA, SPIB, WCLIB, WWPA, NELMA, NSLB
2000f-1.6E		2,000	1,300	1,825	1,600,000	810,000	NLGA, WWPA
2100f-1.8E		2,100	1,575	1,875	1,800,000	910,000	NLGA, SPIB, WCLIB, WWPA, NELMA, NSLB
2250f-1.7E		2,250	1,750	1,925	1,700,000	860,000	NLGA, WWPA
2250f-1.8E		2,250	1,750	1,925	1,800,000	910,000	NLGA, WCLIB, WWPA
2250f-1.9E		2,250	1,750	1,925	1,900,000	970,000	NLGA, SPIB, WCLIB, WWPA, NELMA, NSLB
2250f-2.0E-1600f <sub>t</sub>		2,250	1,600	1,925	2,000,000	1,020,000	WCLIB, WWPA
2250f-2.0E		2,250	1,750	1,925	2,000,000	1,020,000	WCLIB, WWPA
2400f-1.8E		2,400	1,925	1,975	1,800,000	910,000	NLGA, WWPA
2400f-2.0E		2,400	1,925	1,975	2,000,000	1,020,000	NLGA, SPIB, WCLIB, WWPA, NELMA, NSLB
2500f-2.2E		2,500	1,750	2,000	2,200,000	1,120,000	WCLIB, WWPA
2500f-2.2E-1925f <sub>t</sub>		2,500	1,925	2,000	2,200,000	1,120,000	WCLIB, WWPA
2550f-2.1E		2,550	2,050	2,025	2,100,000	1,070,000	NLGA, SPIB, WCLIB, WWPA, NELMA, NSLB
2700f-2.0E	2,700	1,800	2,100	2,000,000	1,020,000	WCLIB, WWPA	
2700f-2.2E	2,700	2,150	2,100	2,200,000	1,120,000	NLGA, SPIB, WCLIB, WWPA, NELMA, NSLB	
2850f-2.3E	2,850	2,300	2,150	2,300,000	1,170,000	NLGA, SPIB, WCLIB, WWPA, NELMA, NSLB	
3000f-2.4E	3,000	2,400	2,200	2,400,000	1,220,000	NLGA, SPIB	

**Table 4C Reference Design Values for Mechanically Graded Dimension Lumber<sup>1,2,3</sup>**  
**(Cont.)** (Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4C ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)					Grading Rules Agency
		Bending F <sub>b</sub>	Tension parallel to grain F <sub>t</sub>	Compression parallel to grain F <sub>c</sub>	Modulus of Elasticity		
					E	E <sub>min</sub>	
<b>MACHINE EVALUATED LUMBER (MEL)</b>							
M-5	2" and less in thickness  2" and wider	900	500	1,050	1,100,000	510,000	SPIB
M-6		1,100	600	1,300	1,000,000	470,000	SPIB
M-7		1,200	650	1,400	1,100,000	510,000	SPIB
M-8		1,300	700	1,500	1,300,000	610,000	SPIB
M-9		1,400	800	1,600	1,400,000	650,000	SPIB
M-10		1,400	800	1,600	1,200,000	560,000	NLGA, SPIB
M-11		1,550	850	1,675	1,500,000	700,000	NLGA, SPIB
M-12		1,600	850	1,675	1,600,000	750,000	NLGA, SPIB
M-13		1,600	950	1,675	1,400,000	650,000	NLGA, SPIB
M-14		1,800	1,000	1,750	1,700,000	790,000	NLGA, SPIB
M-15		1,800	1,100	1,750	1,500,000	700,000	NLGA, SPIB
M-16		1,800	1,300	1,750	1,500,000	700,000	SPIB
M-17[4]		1,950	1,300	2,050	1,700,000	790,000	SPIB
M-18		2,000	1,200	1,825	1,800,000	840,000	NLGA, SPIB
M-19		2,000	1,300	1,825	1,600,000	750,000	NLGA, SPIB
M-20[4]		2,000	1,600	2,100	1,900,000	890,000	SPIB
M-21		2,300	1,400	1,950	1,900,000	890,000	NLGA, SPIB
M-22		2,350	1,500	1,950	1,700,000	790,000	NLGA, SPIB
M-23		2,400	1,900	1,975	1,800,000	840,000	NLGA, SPIB
M-24		2,700	1,800	2,100	1,900,000	890,000	NLGA, SPIB
M-25		2,750	2,000	2,100	2,200,000	1,030,000	NLGA, SPIB
M-26		2,800	1,800	2,150	2,000,000	930,000	NLGA, SPIB
M-27[4]		3,000	2,000	2,400	2,100,000	980,000	SPIB
M-28		2,200	1,600	1,900	1,700,000	790,000	SPIB
M-29		1,550	850	1,650	1,700,000	790,000	SPIB
M-30		2,050	1,050	1,850	1,700,000	790,000	SPIB
M-31		2,850	1,600	2,150	1,900,000	890,000	SPIB

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REFERENCE DESIGN VALUES

**Table 4C Footnotes**

- 1. LUMBER DIMENSIONS.** Tabulated design values are applicable to lumber that will be used under dry conditions such as in most covered structures. For 2" to 4" thick lumber the DRY dressed sizes shall be used (see Table 1A) regardless of the moisture content at the time of manufacture or use. In calculating design values, the natural gain in strength and stiffness that occurs as lumber dries has been taken into consideration as well as the reduction in size that occurs when unseasoned lumber shrinks. The gain in load carrying capacity due to increased strength and stiffness resulting from drying more than offsets the design effect of size reductions due to shrinkage.
- 2. SPECIFIC GRAVITY, G, SHEAR PARALLEL TO GRAIN, F<sub>v</sub>, AND COMPRESSION PERPENDICULAR TO GRAIN, F<sub>c⊥</sub>.** Values for specific gravity, G, shear parallel to grain, F<sub>v</sub>, and compression perpendicular to grain, F<sub>c⊥</sub>, are provided below for MSR and MEL lumber. For species or species groups not shown below, the G, F<sub>v</sub>, and F<sub>c⊥</sub> values for visually graded lumber may be used. Higher G values may be claimed when (a) specifically assigned by the rules writing agency or (b) when qualified by test, quality controlled for G and provided for on the grade stamp. When a different G value is provided on the grade stamp, higher F<sub>v</sub> and F<sub>c⊥</sub> design values may be calculated in accordance with the grading rule requirements.

Species	Modulus of Elasticity E (x10 <sup>6</sup> ), psi	Design Values			Grading Rules Agency
		Specific Gravity G	Shear Parallel to Grain F <sub>v</sub> , psi	Compression Perpendicular to Grain F <sub>c⊥</sub> , psi	
Douglas Fir-Larch	1.0 and higher	0.50	180	625	WCLIB, WWPA
	2.0	0.51	180	670	WCLIB, WWPA
	2.1	0.52	180	690	
	2.2	0.53	180	715	
	2.3	0.54	185	735	
	2.4	0.55	185	760	
Douglas Fir-Larch (N)	1.2 to 1.9	0.49	180	625	NLGA
	2.0 to 2.2	0.53	180	715	
	2.3 and higher	0.57	190	715	
Douglas Fir-South	1.0 and higher	0.46	180	520	WWPA
Englemann Spruce-Lodgepole Pine	1.0 and higher	0.38	135	335	WWPA
Hem-Fir	1.5 and higher	0.46	160	555	WWPA
	1.0 and higher	0.43	150	405	WCLIB, WWPA
	1.6	0.44	155	510	WCLIB, WWPA
	1.7	0.45	160	535	
	1.8	0.46	160	555	
	1.9	0.47	165	580	
	2.0	0.48	170	600	
	2.1	0.49	170	625	
	2.2	0.50	175	645	
	2.3	0.51	190	670	
2.4	0.52	190	690		
Hem-Fir (N)	1.0 and higher	0.46	145	405	NLGA
Southern Pine	1.0 and higher	0.55	175	565	SPIB
	1.8 and higher	0.57	190	805	SPIB
Spruce-Pine-Fir	1.2 and higher	0.42	135	425	NLGA
	1.8 to 1.9	0.46	160	525	NLGA
	2.0 and higher	0.50	170	615	NLGA
Spruce-Pine-Fir (South)	1.0 and higher	0.36	135	335	NELMA, NSLB, WCLIB, WWPA
	1.2 to 1.9	0.42	150	465	NELMA, NSLB
	1.2 to 1.7	0.42	150	465	WWPA
	1.8 to 1.9	0.46	160	555	
2.0 and higher	0.50	175	645	NELMA, NSLB, WWPA	
Western Cedars	1.0 and higher	0.36	155	425	WCLIB, WWPA
Western Woods	1.0 and higher	0.36	135	335	WCLIB, WWPA

- 3. MODULUS OF ELASTICITY, E, AND TENSION PARALLEL TO GRAIN, F<sub>t</sub>.** For any given bending design value, F<sub>b</sub>, the modulus of elasticity, E, and tension parallel to grain, F<sub>t</sub>, design value may vary depending upon species, timber source, or other variables. The "E" and "F<sub>t</sub>" values included in the "F<sub>b</sub>-E" grade designations in Table 4C are those usually associated with each "F<sub>b</sub>" level. Grade stamps may show higher or lower values if machine rating indicates the assignment is appropriate. Where the "E" or "F<sub>t</sub>" values shown on a grade stamp differ from Table 4C values associated with the "F<sub>b</sub>" on the grade stamp, the values on the stamp shall be used in design, and the "F<sub>c</sub>" value associated with the "F<sub>b</sub>" value in Table 4C shall be used.
- 4. COMPRESSION PARALLEL TO GRAIN, F<sub>c</sub>.** This grade requires "F<sub>c</sub>" qualification and quality control.

## Table 4D Adjustment Factors

### Size Factor, $C_F$

When the depth,  $d$ , of a beam, stringer, post, or timber exceeds 12", the tabulated bending design value,  $F_b$ , shall be multiplied by the following size factor:

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

When beams and stringers are subjected to loads applied to the wide face, tabulated design values shall be multiplied by the following size factors:

Size Factors, $C_F$			
Grade	$F_b$	E and $E_{min}$	Other Properties
Select Structural	0.86	1.00	1.00
No.1	0.74	0.90	1.00
No.2	1.00	1.00	1.00

### Wet Service Factor, $C_M$

When timbers are used where moisture content will exceed 19% for an extended time period, design values shall be multiplied by the appropriate wet service factors from the following table (for Southern Pine and Mixed Southern Pine use tabulated design values without further adjustment):

Wet Service Factors, $C_M$					
$F_b$	$F_t$	$F_v$	$F_{c\perp}$	$F_c$	E and $E_{min}$
1.00	1.00	1.00	0.67	0.91	1.00

only to be used with the 2005 NDS® and Wood Structural Design Data

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REFERENCE DESIGN VALUES

**Table 4D Reference Design Values for Visually Graded Timbers (5" x 5" and larger)<sup>1,3</sup>**  
 (Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4D ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency	
		Bending F <sub>b</sub>	Tension parallel to grain F <sub>t</sub>	Shear parallel to grain F <sub>v</sub>	Compression perpendicular to grain F <sub>cL</sub>	Compression parallel to grain F <sub>c</sub>	Modulus of Elasticity			
							E	E <sub>min</sub>		
<b>ALASKA CEDAR</b>										
Select Structural No.1	Beams and Stringers	1,400	675	155	525	925	1,200,000	440,000	WCLIB	
		1,150	475	155	525	775	1,200,000	440,000		
		750	300	155	525	500	1,000,000	370,000		
Select Structural No.1	Posts and Timbers	1,300	700	155	525	975	1,200,000	440,000		
		1,050	575	155	525	850	1,200,000	440,000		
		625	350	155	525	600	1,000,000	370,000		
<b>BALDCYPRESS</b>										
Select Structural No.1	5"x5" and Larger	1,150	750	200	615	1,050	1,300,000	470,000	SPIB	
		1,000	675	200	615	925	1,300,000	470,000		
		625	425	175	615	600	1,000,000	370,000		
Select Structural No.1	Beams and Stringers	1,350	900	125	305	950	1,400,000	510,000		NELMA
		1,100	750	125	305	800	1,400,000	510,000		
		725	350	125	305	500	1,100,000	400,000		
Select Structural No.1	Posts and Timbers	1,250	825	125	305	1,000	1,400,000	510,000		
		1,000	675	125	305	875	1,400,000	510,000		
		575	375	125	305	400	1,100,000	400,000		
<b>BEECH-BIRCH-HICKORY</b>										
Select Structural No.1	Beams and Stringers	1,650	975	180	715	975	1,500,000	550,000	NELMA	
		1,400	700	180	715	825	1,500,000	550,000		
		900	450	180	715	525	1,200,000	440,000		
Select Structural No.1	Posts and Timbers	1,550	1,050	180	715	1,050	1,500,000	550,000		
		1,250	850	180	715	900	1,500,000	550,000		
		725	475	180	715	425	1,200,000	440,000		
<b>COAST SITKA SPRUCE</b>										
Select Structural No.1	Beams and Stringers	1,150	675	115	455	775	1,500,000	550,000	NLGA	
		950	475	115	455	650	1,500,000	550,000		
		625	325	115	455	425	1,200,000	440,000		
Select Structural No.1	Posts and Timbers	1,100	725	115	455	825	1,500,000	550,000		
		875	575	115	455	725	1,500,000	550,000		
		525	350	115	455	500	1,200,000	440,000		
<b>DOUGLAS FIR-LARCH</b>										
Dense Select Structural No.1	Beams and Stringers	1,900	1,100	170	730	1,300	1,700,000	620,000	WCLIB	
		1,600	950	170	625	1,100	1,600,000	580,000		
		1,550	775	170	730	1,100	1,700,000	620,000		
	Posts and Timbers	1,350	675	170	625	925	1,600,000	580,000		
		875	425	170	625	600	1,300,000	470,000		
		1,750	1,150	170	730	1,350	1,700,000	620,000		
Dense Select Structural No.1	Posts and Timbers	1,500	1,000	170	625	1,150	1,600,000	580,000		
		1,400	950	170	730	1,200	1,700,000	620,000		
		1,200	825	170	625	1,000	1,600,000	580,000		
Dense Select Structural No.2	Beams and Stringers	1,900	1,100	170	730	1,300	1,700,000	620,000	WWPA	
		1,600	950	170	625	1,100	1,600,000	580,000		
		1,550	775	170	730	1,100	1,700,000	620,000		
	Posts and Timbers	1,350	675	170	625	925	1,600,000	580,000		
		1,000	500	170	730	700	1,400,000	510,000		
		875	425	170	625	600	1,300,000	470,000		
Dense Select Structural No.2	Posts and Timbers	1,750	1,150	170	730	1,350	1,700,000	620,000		
		1,500	1,000	170	625	1,150	1,600,000	580,000		
		1,400	950	170	730	1,200	1,700,000	620,000		
Dense Select Structural No.2	Posts and Timbers	1,200	825	170	625	1,000	1,600,000	580,000		
		850	550	170	730	825	1,400,000	510,000		
		750	475	170	625	700	1,300,000	470,000		

**Table 4D Reference Design Values for Visually Graded Timbers (5" x 5" and larger)<sup>1,3</sup> (Cont.)**  
 (Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4D ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending F <sub>b</sub>	Tension parallel to grain F <sub>t</sub>	Shear parallel to grain F <sub>v</sub>	Compression perpendicular to grain F <sub>cL</sub>	Compression parallel to grain F <sub>c</sub>	Modulus of Elasticity		
							E	E <sub>min</sub>	
<b>DOUGLAS FIR-LARCH (NORTH)</b>									
Select Structural No.1 No.2	Beams and Stringers	1,600	950	170	625	1,100	1,600,000	580,000	NLGA
		1,300	675	170	625	925	1,600,000	580,000	
		875	425	170	625	600	1,300,000	470,000	
Select Structural No.1 No.2	Posts and Timbers	1,500	1,000	170	625	1,150	1,600,000	580,000	
		1,200	825	170	625	1,000	1,600,000	580,000	
		725	475	170	625	700	1,300,000	470,000	
<b>DOUGLAS FIR-SOUTH</b>									
Select Structural No.1 No.2	Beams and Stringers	1,550	900	165	520	1,000	1,200,000	440,000	WWPA
		1,300	625	165	520	850	1,200,000	440,000	
		825	425	165	520	550	1,000,000	370,000	
Select Structural No.1 No.2	Posts and Timbers	1,450	950	165	520	1,050	1,200,000	440,000	
		1,150	775	165	520	925	1,200,000	440,000	
		675	450	165	520	650	1,000,000	370,000	
<b>EASTERN HEMLOCK</b>									
Select Structural No.1 No.2	Beams and Stringers	1,350	925	155	550	950	1,200,000	440,000	NELMA
		1,150	775	155	550	800	1,200,000	440,000	
		750	375	155	550	550	900,000	330,000	
Select Structural No.1 No.2	Posts and Timbers	1,250	850	155	550	1,000	1,200,000	440,000	
		1,050	700	155	500	875	1,200,000	440,000	
		600	400	155	550	400	900,000	330,000	
<b>EASTERN HEMLOCK-TAMARACK</b>									
Select Structural No.1 No.2	Beams and Stringers	1,400	925	155	555	950	1,200,000	440,000	NELMA
		1,150	775	155	555	800	1,200,000	440,000	
		750	375	155	555	500	900,000	330,000	
Select Structural No.1 No.2	Posts and Timbers	1,300	875	155	555	1,000	1,200,000	440,000	
		1,050	700	155	555	875	1,200,000	440,000	
		600	400	155	555	400	900,000	330,000	
<b>EASTERN HEMLOCK-TAMARACK (N)</b>									
Select Structural No.1 No.2	Beams and Stringers	1,450	850	165	555	950	1,300,000	470,000	NLGA
		1,200	600	165	555	800	1,300,000	470,000	
		775	400	165	555	500	1,100,000	400,000	
Select Structural No.1 No.2	Posts and Timbers	1,350	900	165	555	1,000	1,300,000	470,000	
		1,100	725	165	555	875	1,300,000	470,000	
		650	425	165	555	600	1,100,000	400,000	
<b>EASTERN SPRUCE</b>									
Select Structural No.1 No.2	Beams and Stringers	1,050	725	135	390	750	1,400,000	510,000	NELMA
		900	600	135	390	625	1,400,000	510,000	
		575	275	135	390	375	1,000,000	370,000	
Select Structural No.1 No.2	Posts and Timbers	1,000	675	135	390	775	1,400,000	510,000	
		800	550	135	390	675	1,400,000	510,000	
		450	300	135	390	300	1,000,000	370,000	
<b>EASTERN WHITE PINE</b>									
Select Structural No.1 No.2	Beams and Stringers	1,050	700	125	350	675	1,100,000	400,000	NELMA
		875	600	125	350	575	1,100,000	400,000	
		575	275	125	350	400	900,000	330,000	
Select Structural No.1 No.2	Posts and Timbers	975	650	125	350	725	1,100,000	400,000	
		800	525	125	350	625	1,100,000	400,000	
		450	300	125	350	325	900,000	330,000	

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REFERENCE DESIGN VALUES

**Table 4D Reference Design Values for Visually Graded Timbers (5" x 5" and larger)<sup>1,3</sup>**  
**(Cont.)** (Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4D ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending F <sub>b</sub>	Tension parallel to grain F <sub>t</sub>	Shear parallel to grain F <sub>v</sub>	Compression perpendicular to grain F <sub>cL</sub>	Compression parallel to grain F <sub>c</sub>	Modulus of Elasticity		
							E	E <sub>min</sub>	
<b>HEM-FIR</b>									
Select Structural	Beams and Stringers	1,300	750	140	405	925	1,300,000	470,000	WCLIB WWPA
No.1		1,050	525	140	405	750	1,300,000	470,000	
No.2		675	350	140	405	500	1,100,000	400,000	
Select Structural	Posts and Timbers	1,200	800	140	405	975	1,300,000	470,000	
No.1		975	650	140	405	850	1,300,000	470,000	
No.2		575	375	140	405	575	1,100,000	400,000	
<b>HEM-FIR (NORTH)</b>									
Select Structural	Beams and Stringers	1,250	725	135	405	900	1,300,000	470,000	NLGA
No.1		1,000	500	135	405	750	1,300,000	470,000	
No.2		675	325	135	405	475	1,100,000	400,000	
Select Structural	Posts and Timbers	1,150	775	135	405	950	1,300,000	470,000	
No.1		925	625	135	405	850	1,300,000	470,000	
No.2		550	375	135	405	575	1,100,000	400,000	
<b>MIXED MAPLE</b>									
Select Structural	Beams and Stringers	1,150	700	180	620	725	1,100,000	400,000	NELMA
No.1		975	500	180	620	600	1,100,000	400,000	
No.2		625	325	180	620	375	900,000	330,000	
Select Structural	Posts and Timbers	1,100	725	180	620	750	1,100,000	400,000	
No.1		875	600	180	620	650	1,100,000	400,000	
No.2		500	350	180	620	300	900,000	330,000	
<b>MIXED OAK</b>									
Select Structural	Beams and Stringers	1,350	800	155	800	825	1,000,000	370,000	NELMA
No.1		1,150	550	155	800	700	1,000,000	370,000	
No.2		725	375	155	800	450	800,000	290,000	
Select Structural	Posts and Timbers	1,250	850	155	800	875	1,000,000	370,000	
No.1		1,000	675	155	800	775	1,000,000	370,000	
No.2		575	400	155	800	350	800,000	290,000	
<b>MIXED SOUTHERN PINE<sup>2</sup></b>									
<b>(Wet Service Conditions)</b>									
Select Structural	5"x5" and Larger	1,500	1,000	165	375	900	1,300,000	470,000	SPIB
No.1		1,350	900	165	375	800	1,300,000	470,000	
No.2		850	550	165	375	525	1,000,000	370,000	
<b>MOUNTAIN HEMLOCK</b>									
Select Structural	Beams and Stringers	1,350	775	170	570	875	1,100,000	400,000	WCLIB WWPA
No.1		1,100	550	170	570	725	1,100,000	400,000	
No.2		725	375	170	570	475	900,000	330,000	
Select Structural	Posts and Timbers	1,250	825	170	570	925	1,100,000	400,000	
No.1		1,000	675	170	570	800	1,100,000	400,000	
No.2		625	400	170	570	550	900,000	330,000	
<b>NORTHERN PINE</b>									
Select Structural	Beams and Stringers	1,250	850	135	435	850	1,300,000	470,000	NELMA NSLB
No.1		1,050	700	135	435	725	1,300,000	470,000	
No.2		675	350	135	435	450	1,000,000	370,000	
Select Structural	Posts and Timbers	1,150	800	135	435	900	1,300,000	470,000	
No.1		950	650	135	435	800	1,300,000	470,000	
No.2		550	375	135	435	375	1,000,000	370,000	
<b>NORTHERN RED OAK</b>									
Select Structural	Beams and Stringers	1,600	950	205	885	950	1,300,000	470,000	NELMA
No.1		1,350	675	205	885	800	1,300,000	470,000	
No.2		875	425	205	885	500	1,000,000	370,000	
Select Structural	Posts and Timbers	1,500	1,000	205	885	1,000	1,300,000	470,000	
No.1		1,200	800	205	885	875	1,300,000	470,000	
No.2		700	475	205	885	400	1,000,000	370,000	

**Table 4D Reference Design Values for Visually Graded Timbers (5" x 5" and larger)<sup>1,3</sup> (Cont.)**  
 (Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4D ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending F <sub>b</sub>	Tension parallel to grain F <sub>t</sub>	Shear parallel to grain F <sub>v</sub>	Compression perpendicular to grain F <sub>cL</sub>	Compression parallel to grain F <sub>c</sub>	Modulus of Elasticity		
							E	E <sub>min</sub>	
<b>NORTHERN WHITE CEDAR</b>									
Select Structural	Beams and Stringers	900	600	115	370	600	700,000	260,000	NELMA
No.1		750	500	115	370	500	700,000	260,000	
No.2		500	250	115	370	325	600,000	220,000	
Select Structural	Posts and Timbers	850	575	115	370	650	700,000	260,000	
No.1		675	450	115	370	550	700,000	260,000	
No.2		400	250	115	370	250	600,000	220,000	
<b>PONDEROSA PINE</b>									
Select Structural	Beams and Stringers	1,100	725	130	535	750	1,100,000	400,000	NLGA
No.1		925	500	130	535	625	1,100,000	400,000	
No.2		600	300	130	535	400	900,000	330,000	
Select Structural	Posts and Timbers	1,000	675	130	535	800	1,100,000	400,000	
No.1		825	550	130	535	700	1,100,000	400,000	
No.2		475	325	130	535	325	900,000	330,000	
<b>RED MAPLE</b>									
Select Structural	Beams and Stringers	1,500	875	195	615	900	1,500,000	550,000	NELMA
No.1		1,250	625	195	615	750	1,500,000	550,000	
No.2		800	400	195	615	475	1,200,000	440,000	
Select Structural	Posts and Timbers	1,400	925	195	615	950	1,500,000	550,000	
No.1		1,150	750	195	615	825	1,500,000	550,000	
No.2		650	425	195	615	375	1,200,000	440,000	
<b>RED OAK</b>									
Select Structural	Beams and Stringers	1,350	800	155	820	825	1,200,000	440,000	NELMA
No.1		1,150	550	155	820	700	1,200,000	440,000	
No.2		725	375	155	820	450	1,000,000	370,000	
Select Structural	Posts and Timbers	1,250	850	155	820	875	1,200,000	440,000	
No.1		1,000	675	155	820	775	1,200,000	440,000	
No.2		575	400	155	820	350	1,000,000	370,000	
<b>RED PINE</b>									
Select Structural	Beams and Stringers	1,050	625	130	440	725	1,100,000	400,000	NLGA
No.1		875	450	130	440	600	1,100,000	400,000	
No.2		575	300	130	440	375	900,000	330,000	
Select Structural	Posts and Timbers	1,000	675	130	440	775	1,100,000	400,000	
No.1		800	550	130	440	675	1,100,000	400,000	
No.2		475	325	130	440	475	900,000	330,000	
<b>REDWOOD</b>									
Clear Structural	5" x 5" and Larger	1,850	1,250	145	650	1,650	1,300,000	470,000	RIS
Select Structural		1,400	950	145	650	1,200	1,300,000	470,000	
Select Structural OG		1,100	750	145	420	900	1,000,000	370,000	
No.1		1,200	800	145	650	1,050	1,300,000	470,000	
No.1 OG		950	650	145	420	800	1,000,000	370,000	
No.2		1,000	525	145	650	900	1,100,000	400,000	
No.2 OG		750	400	145	420	650	900,000	330,000	
<b>SITKA SPRUCE</b>									
Select Structural	Beams and Stringers	1,200	675	140	435	825	1,300,000	470,000	WCLIB
No.1		1,000	500	140	435	675	1,300,000	470,000	
No.2		650	325	140	435	450	1,000,000	370,000	
Select Structural	Posts and Timbers	1,150	750	140	435	875	1,300,000	470,000	
No.1		925	600	140	435	750	1,300,000	470,000	
No.2		550	350	140	435	525	1,000,000	370,000	
Select Structural	Beams and Stringers	1,200	675	140	435	825	1,300,000	470,000	WWPA
No.1		1,000	500	140	435	675	1,300,000	470,000	
No.2		650	325	140	435	450	1,100,000	400,000	
Select Structural	Posts and Timbers	1,150	750	140	435	875	1,300,000	470,000	
No.1		925	600	140	435	750	1,300,000	470,000	
No.2		550	350	140	435	525	1,100,000	400,000	

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**Table 4D Reference Design Values for Visually Graded Timbers (5" x 5" and larger)<sup>1,3</sup> (Cont.)**  
 (Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4D ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending F <sub>b</sub>	Tension parallel to grain F <sub>t</sub>	Shear parallel to grain F <sub>v</sub>	Compression perpendicular to grain F <sub>cL</sub>	Compression parallel to grain F <sub>c</sub>	Modulus of Elasticity		
							E	E <sub>min</sub>	
<b>SOUTHERN PINE</b>		<b>(Wet Service Conditions)</b>							
Dense Select Structural	5" x 5" and Larger	1,750	1,200	165	440	1,100	1,600,000	580,000	SPIB
Select Structural		1,500	1,000	165	375	950	1,500,000	550,000	
No.1 Dense		1,550	1,050	165	440	975	1,600,000	580,000	
No.1		1,350	900	165	375	825	1,500,000	550,000	
No.2 Dense		975	650	165	440	625	1,300,000	470,000	
No.2		850	550	165	375	525	1,200,000	440,000	
Dense Select Structural 86		2,100	1,400	165	440	1,300	1,600,000	580,000	
Dense Select Structural 72		1,750	1,200	165	440	1,100	1,600,000	580,000	
Dense Select Structural 65		1,600	1,050	165	440	1,000	1,600,000	580,000	
<b>SPRUCE-PINE-FIR</b>									
Select Structural	Beams and Stringers	1,100	650	125	425	775	1,300,000	470,000	NLGA
No.1		900	450	125	425	625	1,300,000	470,000	
No.2		600	300	125	425	425	1,000,000	370,000	
Select Structural	Posts and Timbers	1,050	700	125	425	800	1,300,000	470,000	
No.1		850	550	125	425	700	1,300,000	470,000	
No.2		500	325	125	425	500	1,000,000	370,000	
<b>SPRUCE-PINE-FIR (SOUTH)</b>									
Select Structural	Beams and Stringers	1,050	625	125	335	675	1,200,000	440,000	NELMA NSLB
No.1		900	450	125	335	550	1,200,000	440,000	
No.2		575	300	125	335	375	1,000,000	370,000	
Select Structural	Posts and Timbers	1,000	675	125	335	700	1,200,000	440,000	
No.1		800	550	125	335	625	1,200,000	440,000	
No.2		475	325	125	335	425	1,000,000	370,000	
<b>WESTERN CEDARS</b>									
Select Structural	Beams and Stringers	1,150	675	140	425	875	1,000,000	370,000	WCLIB
No.1		975	475	140	425	725	1,000,000	370,000	
No.2		625	325	140	425	475	800,000	290,000	
Select Structural	Posts and Timbers	1,100	725	140	425	925	1,000,000	370,000	
No.1		875	600	140	425	800	1,000,000	370,000	
No.2		550	350	140	425	550	800,000	290,000	
<b>WESTERN CEDARS (NORTH)</b>									
Select Structural	Beams and Stringers	1,150	675	130	425	850	1,000,000	370,000	NLGA
No.1		925	475	130	425	700	1,000,000	370,000	
No.2		625	300	130	425	450	800,000	290,000	
Select Structural	Posts and Timbers	1,050	700	130	425	900	1,000,000	370,000	
No.1		875	575	130	425	800	1,000,000	370,000	
No.2		500	350	130	425	550	800,000	290,000	
<b>WESTERN HEMLOCK</b>									
Select Structural	Beams and Stringers	1,400	825	170	410	1,000	1,400,000	510,000	WCLIB
No.1		1,150	575	170	410	850	1,400,000	510,000	
No.2		750	375	170	410	550	1,100,000	400,000	
Select Structural	Posts and Timbers	1,300	875	170	410	1,100	1,400,000	510,000	
No.1		1,050	700	170	410	950	1,400,000	510,000	
No.2		650	425	170	410	650	1,100,000	400,000	
<b>WESTERN HEMLOCK (NORTH)</b>									
Select Structural	Beams and Stringers	1,400	825	135	410	1,000	1,400,000	510,000	NLGA
No.1		1,150	575	135	410	850	1,400,000	510,000	
No.2		750	375	135	410	550	1,100,000	400,000	
Select Structural	Posts and Timbers	1,300	875	135	410	1,100	1,400,000	510,000	
No.1		1,050	700	135	410	950	1,400,000	510,000	
No.2		650	425	135	410	650	1,100,000	400,000	

only to be used with the 2005 NDS® and Wood Structural Design Data

**4** REFERENCE DESIGN VALUES

**Table 4D Reference Design Values for Visually Graded Timbers (5" x 5" and larger)<sup>1,3</sup>**  
**(Cont.)** (Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4D ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{cL}$	Compression parallel to grain $F_c$	Modulus of Elasticity		
							E	$E_{min}$	
<b>WESTERN WHITE PINE</b>									
Select Structural	Beams and Stringers	1,050	600	120	375	775	1,300,000	470,000	NLGA
No.1		850	425	120	375	625	1,300,000	470,000	
No.2		550	275	120	375	400	1,000,000	370,000	
Select Structural	Posts and Timbers	975	650	120	375	800	1,300,000	470,000	
No.1		775	525	120	375	700	1,300,000	470,000	
No.2		450	300	120	375	500	1,000,000	370,000	
<b>WESTERN WOODS</b>									
Select Structural	Beams and Stringers	1,050	625	125	345	750	1,100,000	400,000	WCLIB
No.1		900	450	125	345	625	1,100,000	400,000	
No.2		575	300	125	345	425	900,000	330,000	
Select Structural	Posts and Timbers	1,000	675	125	345	800	1,100,000	400,000	
No.1		800	525	125	345	700	1,100,000	400,000	
No.2		475	325	125	345	475	900,000	330,000	
<b>WHITE OAK</b>									
Select Structural	Beams and Stringers	1,400	825	205	800	900	1,000,000	370,000	NELMA
No.1		1,200	575	205	800	775	1,000,000	370,000	
No.2		750	375	205	800	475	800,000	290,000	
Select Structural	Posts and Timbers	1,300	875	205	800	950	1,000,000	370,000	
No.1		1,050	700	205	800	825	1,000,000	370,000	
No.2		600	400	205	800	400	800,000	290,000	

**Footnotes to Table 4D**

- LUMBER DIMENSIONS.** Tabulated design values are applicable to lumber that will be used under dry conditions such as in most covered structures. For 5" and thicker lumber, the GREEN dressed sizes shall be permitted to be used (see Table 1A) because design values have been adjusted to compensate for any loss in size by shrinkage which may occur.
- SPRUCE PINE.** To obtain recommended design values for Spruce Pine graded to Southern Pine Inspection Bureau (SPIB) rules, multiply the appropriate design values for Mixed Southern Pine by the corresponding conversion factor shown below and round to the nearest 100,000 psi for E; to the nearest 10,000 psi for  $E_{min}$ ; to the next lower multiple of 5 psi for  $F_v$  and  $F_{cL}$ ; to the next lower multiple of 50 psi for  $F_b$ ,  $F_t$ , and  $F_c$  if 1,000 psi or greater, 25 psi otherwise.

**CONVERSION FACTORS FOR DETERMINING DESIGN VALUES FOR SPRUCE PINE**

	Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{cL}$	Compression parallel to grain $F_c$	Modulus of Elasticity E and $E_{min}$
Conversion Factor	0.78	0.78	0.98	0.73	0.78	0.82

- When individual species or species groups are combined, the design values to be used for the combination shall be the lowest design values for each individual species or species group for each design property.



**Table 4E Adjustment Factors****Size Factor,  $C_F$** 

Bending design values for all species of decking except Redwood are based on 4" thick decking. When 2" thick or 3" thick decking is used, the bending design values,  $F_b$ , for all species except Redwood shall be multiplied by the following size factors:

Size Factors, $C_F$	
Thickness	$C_F$
2"	1.10
3"	1.04

**Repetitive Member Factor,  $C_r$** 

Tabulated bending design values for repetitive member uses,  $(F_b)(C_r)$ , for decking have already been multiplied by the repetitive member factor,  $C_r$ .

**Flat Use Factor,  $C_{fu}$** 

Tabulated bending design values,  $F_b$ , for decking have already been adjusted for flatwise usage (load applied to wide face).

**Wet Service Factor,  $C_M$** 

When decking is used where moisture content will exceed 19% for an extended time period, design values shall be multiplied by the appropriate wet service factors from the following table (for surfaced dry Southern Pine decking use tabulated surfaced green design values for wet service conditions without further adjustment):

Wet Service Factors, $C_M$		
$F_b$	$F_{c\perp}$	E and $E_{min}$
0.85*	0.67	0.9

\* when  $(F_b)(C_F) \leq 1,150$  psi,  $C_M = 1.0$

**Table 4E Reference Design Values for Visually Graded Decking<sup>1,2</sup>**

(Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4E ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)					Grading Rules Agency
		Bending		Compression perpendicular to grain $F_{c\perp}$	Modulus of Elasticity		
		Single Member $F_b$	Repetitive Member ( $F_b$ )( $C_r$ )		E	$E_{min}$	
<b>BALSAM FIR</b>							
Select	2" - 4" thick	—	1,650	—	1,500,000	550,000	NELMA
Commercial	4" - 12" wide	—	1,400	—	1,300,000	470,000	
<b>COAST SITKA SPRUCE</b>							
Select	2" - 4" thick	1,250	1,450	455	1,700,000	620,000	NLGA
Commercial	4" & wider	1,050	1,200	455	1,500,000	550,000	
<b>COAST SPECIES</b>							
Select	2" - 4" thick	1,250	1,450	370	1,500,000	550,000	NLGA
Commercial	4" & wider	1,050	1,200	370	1,400,000	510,000	
<b>DOUGLAS FIR-LARCH</b>							
Select Dex	2" - 4" thick	1,750	2,000	625	1,800,000	660,000	WCLIB
Commercial Dex	6" - 8" wide	1,450	1,650	625	1,700,000	620,000	
Selected	2" - 4" thick	1,750	2,000	625	1,800,000	660,000	WWPA
Commercial	4" & wider	1,450	1,650	625	1,700,000	620,000	
<b>DOUGLAS FIR-LARCH (NORTH)</b>							
Select	2" - 4" thick	1,750	2,000	625	1,800,000	660,000	NLGA
Commercial	4" & wider	1,450	1,650	625	1,700,000	620,000	
<b>DOUGLAS FIR-SOUTH</b>							
Selected	2" - 4" thick	1,650	1,900	520	1,400,000	510,000	WWPA
Commercial	4" & wider	1,400	1,600	520	1,300,000	470,000	
<b>EASTERN HEMLOCK-TAMARACK</b>							
Select	2" - 4" thick	—	1,700	—	1,300,000	470,000	NELMA
Commercial	4" - 12" wide	—	1,450	—	1,100,000	400,000	
<b>EASTERN HEMLOCK-TAMARACK (NORTH)</b>							
Select	2" - 4" thick	1,500	1,700	555	1,300,000	470,000	NLGA
Commercial	4" & wider	1,250	1,450	555	1,100,000	400,000	
<b>EASTERN SPRUCE</b>							
Select	2" - 4" thick	—	1,300	—	1,500,000	550,000	NELMA
Commercial	4" - 12" wide	—	1,100	—	1,400,000	510,000	
<b>EASTERN WHITE PINE</b>							
Select	2" - 4" thick	—	1,300	—	1,200,000	440,000	NELMA
Commercial	4" - 12" wide	—	1,100	—	1,100,000	400,000	
<b>EASTERN WHITE PINE (NORTH)</b>							
Select	2" - 4" thick	900	1,050	350	1,200,000	440,000	NLGA
Commercial	4" & wider	775	875	350	1,100,000	400,000	
<b>HEM-FIR</b>							
Select Dex	2" - 4" thick	1,400	1,600	405	1,500,000	550,000	WCLIB
Commercial Dex	6" - 8" wide	1,150	1,350	405	1,400,000	510,000	
Selected	2" - 4" thick	1,400	1,600	405	1,500,000	550,000	WWPA
Commercial	4" & wider	1,150	1,350	405	1,400,000	510,000	
<b>HEM-FIR (NORTH)</b>							
Select	2" - 4" thick	1,350	1,500	405	1,500,000	550,000	NLGA
Commercial	4" & wider	1,100	1,300	405	1,400,000	510,000	
<b>NORTHERN PINE</b>							
Select	2" - 4" thick	—	1,550	—	1,400,000	510,000	NELMA
Commercial	4" - 12" wide	—	1,300	—	1,300,000	470,000	
<b>NORTHERN SPECIES</b>							
Select	2" - 4" thick	900	1,050	350	1,100,000	400,000	NLGA
Commercial	4" & wider	775	875	350	1,000,000	370,000	

**Table 4E Reference Design Values for Visually Graded Decking<sup>1,2</sup>**  
**(Cont.)**

(Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

USE WITH TABLE 4E ADJUSTMENT FACTORS

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)					Grading Rules Agency
		Bending		Compression perpendicular to grain F <sub>cL</sub>	Modulus of Elasticity		
		Single Member F <sub>b</sub>	Repetitive Member (F <sub>b</sub> )(C <sub>r</sub> )		E	E <sub>min</sub>	
<b>NORTHERN WHITE CEDAR</b>							
Select	2" - 4" thick	—	1,100	—	800,000	290,000	NELMA
Commercial	4" - 12" wide	—	950	—	700,000	260,000	
<b>PONDEROSA PINE</b>							
Select	2" - 4" thick	1,200	1,450	535	1,300,000	470,000	NLGA
Commercial	4" & wider	1,000	1,250	535	1,100,000	400,000	
<b>RED PINE</b>							
Select	2" - 4" thick	1,150	1,350	440	1,300,000	470,000	NLGA
Commercial	4" & wider	975	1,100	440	1,200,000	440,000	
<b>REDWOOD</b>							
Select, Close grain	2" thick	1,850	2,150	—	1,400,000	510,000	RIS
Select	6" & wider	1,450	1,700	—	1,100,000	400,000	
Commercial		1,200	1,350	—	1,000,000	370,000	
Deck Heart and	2" thick 4" wide	400	450	420	900,000	330,000	
Deck Common	2" thick	700	800	420	900,000	330,000	
	6" wide						
<b>SITKA SPRUCE</b>							
Select Dex	2" - 4" thick	1,300	1,500	435	1,500,000	550,000	WCLIB
Commercial Dex	6" - 8" wide	1,100	1,250	435	1,300,000	470,000	
<b>SOUTHERN PINE</b> (Surfaced dry – Used in dry service conditions — 19% or less moisture content)							
Dense Standard	2" - 4" thick	2,000	2,300	660	1,800,000	660,000	SPIB
Dense Select		1,650	1,900	660	1,600,000	580,000	
Select	2" & wider	1,400	1,650	565	1,600,000	580,000	
Dense Commercial		1,650	1,900	660	1,600,000	580,000	
Commercial		1,400	1,650	565	1,600,000	580,000	
<b>SOUTHERN PINE</b> (Surfaced Green – Used in any service condition)							
Dense Standard	2-1/2" - 4" thick	1,600	1,800	440	1,600,000	580,000	SPIB
Dense Select		1,350	1,500	440	1,400,000	510,000	
Select	2" & wider	1,150	1,300	375	1,400,000	510,000	
Dense Commercial		1,350	1,500	440	1,400,000	510,000	
Commercial		1,150	1,300	375	1,400,000	510,000	
<b>SPRUCE-PINE-FIR</b>							
Select	2" - 4" thick	1,200	1,400	425	1,500,000	550,000	NLGA
Commercial	4" & wider	1,000	1,150	425	1,300,000	470,000	
<b>SPRUCE-PINE-FIR (SOUTH)</b>							
Selected	2" - 4" thick	1,150	1,350	335	1,400,000	510,000	NELMA WWPA
Commercial	4" & wider	950	1,100	335	1,200,000	440,000	
<b>WESTERN CEDARS</b>							
Select Dex	2" - 4" thick	1,250	1,450	425	1,100,000	400,000	WCLIB
Commercial Dex	6" - 8" wide	1,050	1,200	425	1,000,000	370,000	
Selected	2" - 4" thick	1,250	1,450	425	1,100,000	400,000	WWPA
Commercial	4" & wider	1,050	1,200	425	1,000,000	370,000	
<b>WESTERN CEDARS (NORTH)</b>							
Select	2" - 4" thick	1,200	1,400	425	1,100,000	400,000	NLGA
Commercial	4" & wider	1,050	1,200	425	1,000,000	370,000	
<b>WESTERN HEMLOCK</b>							
Select Dex	2" - 4" thick	1,500	1,750	410	1,600,000	580,000	WCLIB
Commercial Dex	6" & wider	1,300	1,450	410	1,400,000	510,000	

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**4** REFERENCE DESIGN VALUES

**Table 4E Reference Design Values for Visually Graded Decking<sup>1,2</sup>**  
**(Cont.)**

(Tabulated design values are for normal load duration and dry service conditions, unless specified otherwise. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

USE WITH TABLE 4E ADJUSTMENT FACTORS

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)					Grading Rules Agency
		Bending		Compression perpendicular to grain $F_{c\perp}$	Modulus of Elasticity		
		Single Member $F_b$	Repetitive Member ( $F_b$ )( $C_r$ )		E	$E_{min}$	
<b>WESTERN HEMLOCK (NORTH)</b>							
Select	2" - 4" thick	1,500	1,750	410	1,600,000	580,000	NLGA
Commercial	4" & wider	1,300	1,450	410	1,400,000	510,000	
<b>WESTERN WHITE PINE</b>							
Select	2" - 4" thick	1,100	1,300	375	1,400,000	510,000	NLGA
Commercial	4" & wider	925	1,050	375	1,300,000	470,000	
<b>WESTERN WOODS</b>							
Selected	2" - 4" thick	1,150	1,300	335	1,200,000	440,000	WWPA
Commercial	4" & wider	950	1,100	335	1,100,000	400,000	

- LUMBER DIMENSIONS.** Tabulated design values are applicable to lumber that will be used under dry conditions such as in most covered structures. For 2" to 4" thick lumber the DRY dressed sizes shall be used (see Table 1A) regardless of the moisture content at the time of manufacture or use. In calculating design values, the natural gain in strength and stiffness that occurs as lumber dries has been taken into consideration as well as the reduction in size that occurs when unseasoned lumber shrinks. The gain in load carrying capacity due to increased strength and stiffness resulting from drying more than offsets the design effect of size reductions due to shrinkage.
- When individual species or species groups are combined, the design values to be used for the combination shall be the lowest design values for each individual species or species group for each design property.

**Table 4F Adjustment Factors****Repetitive Member Factor,  $C_r$** 

Bending design values,  $F_b$ , for dimension lumber 2" to 4" thick shall be multiplied by the repetitive member factor,  $C_r = 1.15$ , when such members are used as joists, truss chords, rafters, studs, planks, decking, or similar members which are in contact or spaced not more than 24" on center, are not less than 3 in number, and are joined by floor, roof, or other load distributing elements adequate to support the design load.

**Wet Service Factor,  $C_M$** 

When dimension lumber is used where moisture content will exceed 19% for an extended time period, design values shall be multiplied by the appropriate wet service factors from the following table:

**Wet Service Factors,  $C_M$** 

$F_b$	$F_t$	$F_v$	$F_{c\perp}$	$F_c$	E and $E_{min}$
0.85*	1.0	0.97	0.67	0.8**	0.9

\* when  $(F_b)(C_F) \leq 1,150$  psi,  $C_M = 1.0$

\*\* when  $(F_c)(C_F) \leq 750$  psi,  $C_M = 1.0$

**Flat Use Factor,  $C_{fu}$** 

Bending design values adjusted by size factors are based on edgewise use (load applied to narrow face). When dimension lumber is used flatwise (load applied to wide face), the bending design value,  $F_b$ , shall also be multiplied by the following flat use factors:

**Flat Use Factors,  $C_{fu}$** 

Width (depth)	Thickness (breadth)	
	2" & 3"	4"
2" & 3"	1.0	—
4"	1.1	1.0
5"	1.1	1.05
6"	1.15	1.05
8"	1.15	1.05
10" & wider	1.2	1.1

**NOTE**

To facilitate the use of Table 4F, shading has been employed to distinguish design values based on a 4" nominal width (Construction, Standard, and Utility grades) or a 6" nominal width (Stud grade) from design values based on a 12" nominal width (Select Structural, No.1 & Btr, No.1, No.2, and No.3 grades).

**Size Factor,  $C_F$** 

Tabulated bending, tension, and compression parallel to grain design values for dimension lumber 2" to 4" thick shall be multiplied by the following size factors:

**Size Factors,  $C_F$** 

Grades	Width (depth)	$F_b$		$F_t$	$F_c$
		Thickness (breadth)			
		2" & 3"	4"		
Select Structural, No.1 & Btr, No.1, No.2, No.3	2", 3", & 4"	1.5	1.5	1.5	1.15
	5"	1.4	1.4	1.4	1.1
	6"	1.3	1.3	1.3	1.1
	8"	1.2	1.3	1.2	1.05
	10"	1.1	1.2	1.1	1.0
	12"	1.0	1.1	1.0	1.0
	14" & wider	0.9	1.0	0.9	0.9
Stud	2", 3", & 4"	1.1	1.1	1.1	1.05
	5" & 6"	1.0	1.0	1.0	1.0
	8" & wider	Use No.3 Grade tabulated design values and size factors			
Construction, Standard	2", 3", & 4"	1.0	1.0	1.0	1.0
Utility	4"	1.0	1.0	1.0	1.0
	2" & 3"	0.4	—	0.4	0.6

**Table 4F Reference Design Values for Non-North American Visually Graded Dimension Lumber (2" - 4" thick)<sup>1,3,4</sup>**

(Tabulated design values are for normal load duration and dry service conditions. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4F ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{cL}$	Compression parallel to grain $F_c$	Modulus of Elasticity		
							E	$E_{min}$	
<b>AUSTRIAN SPRUCE - Austria &amp; The Czech Republic</b>									
Select Structural		1,500	675	175	260	1,250	1,700,000	620,000	WCLIB
No.1	2" & wider	1,000	450	175	260	1,100	1,600,000	580,000	
No.2		925	400	175	260	1,050	1,500,000	550,000	
No.3		525	225	175	260	625	1,300,000	470,000	
Stud	2" & wider	725	325	175	260	675	1,300,000	470,000	
Construction	2" - 4" wide	1,050	475	175	260	1,300	1,400,000	510,000	
Standard		575	250	175	260	1,100	1,300,000	470,000	
Utility		275	125	175	260	725	1,200,000	440,000	
<b>DOUGLAS FIR/EUROPEAN LARCH - Austria, The Czech Republic, &amp; Bavaria<sup>2</sup></b>									
Select Structural		1,900	850	195	440	1,400	1,800,000	660,000	WCLIB
No.1	2" & wider	1,400	625	195	440	1,250	1,700,000	620,000	
No.2		1,350	600	195	440	1,250	1,600,000	580,000	
No.3		775	350	195	440	700	1,400,000	510,000	
Stud	2" & wider	800	350	195	440	700	1,400,000	510,000	
Construction	2" - 4" wide	1,000	450	195	440	1,250	1,500,000	550,000	
Standard		575	250	195	440	1,100	1,300,000	470,000	
Utility		275	125	195	440	700	1,300,000	470,000	
<b>MONTANE PINE - South Africa</b>									
Select Structural		975	425	135	325	1,100	1,300,000	470,000	WCLIB
No.1	2" & wider	650	300	135	325	950	1,100,000	400,000	
No.2		600	275	135	325	850	1,000,000	370,000	
No.3		350	150	135	325	475	900,000	330,000	
Stud	2" & wider	475	200	135	325	525	900,000	330,000	
Construction	2" - 4" wide	675	300	135	325	1,050	900,000	330,000	
Standard		375	175	135	325	875	800,000	290,000	
Utility		175	75	135	325	575	800,000	290,000	
<b>NORWAY SPRUCE - Estonia &amp; Lithuania</b>									
Select Structural		1,200	550	150	430	1,200	1,500,000	550,000	WCLIB
No.1	2" & wider	800	375	150	430	1,050	1,400,000	510,000	
No.2		700	300	150	430	925	1,200,000	440,000	
No.3		400	175	150	430	525	1,100,000	400,000	
Stud	2" & wider	550	250	150	430	575	1,100,000	400,000	
Construction	2" - 4" wide	800	350	150	430	1,150	1,100,000	400,000	
Standard		450	200	150	430	950	1,000,000	370,000	
Utility		200	100	150	430	625	1,000,000	370,000	
<b>NORWAY SPRUCE - Finland</b>									
Select Structural		1,350	600	125	220	1,200	1,500,000	550,000	WCLIB
No.1	2" & wider	825	375	125	220	1,000	1,400,000	510,000	
No.2		625	275	125	220	875	1,200,000	440,000	
No.3		375	175	125	220	500	1,100,000	400,000	
Stud	2" & wider	575	250	125	220	600	1,100,000	400,000	
Construction	2" - 4" wide	725	325	125	220	1,100	1,100,000	400,000	
Standard		400	175	125	220	900	1,000,000	370,000	
Utility		200	75	125	220	600	1,000,000	370,000	
<b>NORWAY SPRUCE - Germany, NE France, &amp; Switzerland</b>									
Select Structural		1,200	550	170	355	1,200	1,600,000	580,000	WCLIB
No.1	2" & wider	825	375	170	355	1,050	1,400,000	510,000	
No.2		725	325	170	355	950	1,200,000	440,000	
No.3		425	200	170	355	550	1,100,000	400,000	
Stud	2" & wider	575	250	170	355	600	1,100,000	400,000	
Construction	2" - 4" wide	825	375	170	355	1,200	1,100,000	400,000	
Standard		475	200	170	355	975	1,000,000	370,000	
Utility		225	100	170	355	650	900,000	330,000	

**Table 4F Reference Design Values for Non-North American Visually Graded Dimension Lumber (2" - 4" thick)<sup>1,3,4</sup>**

(Tabulated design values are for normal load duration and dry service conditions. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4F ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency	
		Bending $F_b$	Tension parallel to grain $F_t$	Shear parallel to grain $F_v$	Compression perpendicular to grain $F_{cL}$	Compression parallel to grain $F_c$	Modulus of Elasticity			
							E	$E_{min}$		
<b>NORWAY SPRUCE - Romania &amp; the Ukraine</b>										
Select Structural		1,250	575	100	275	1,200	1,500,000	550,000	WCLIB	
No.1	2" & wider	850	375	100	275	1,050	1,400,000	510,000		
No.2		725	325	100	275	950	1,200,000	440,000		
No.3		425	200	100	275	550	1,100,000	400,000		
Stud	2" & wider	575	250	100	275	600	1,100,000	400,000		
Construction	2" - 4" wide	850	375	100	275	1,200	1,100,000	400,000		
Standard		475	200	100	275	1,000	1,000,000	370,000		
Utility		225	100	100	275	650	1,000,000	370,000		
<b>NORWAY SPRUCE - Sweden</b>										
Select Structural		1,250	550	170	285	1,200	1,600,000	580,000		WCLIB
No.1	2" & wider	825	375	170	285	1,050	1,400,000	510,000		
No.2		675	300	170	285	925	1,200,000	440,000		
No.3		400	175	170	285	525	1,100,000	400,000		
Stud	2" & wider	550	250	170	285	575	1,100,000	400,000		
Construction	2" - 4" wide	775	350	170	285	1,150	1,200,000	440,000		
Standard		425	200	170	285	950	1,100,000	400,000		
Utility		200	100	170	285	625	1,000,000	370,000		
<b>SCOTS PINE - Austria, The Czech Republic, Romania, &amp; the Ukraine</b>										
Select Structural		1,300	600	135	270	1,200	1,700,000	620,000	WCLIB	
No.1	2" & wider	900	400	135	270	1,050	1,600,000	580,000		
No.2		775	350	135	270	1,000	1,400,000	510,000		
No.3		450	200	135	270	575	1,300,000	470,000		
Stud	2" & wider	600	275	135	270	625	1,300,000	470,000		
Construction	2" - 4" wide	875	400	135	270	1,200	1,300,000	470,000		
Standard		500	225	135	270	1,000	1,200,000	440,000		
Utility		225	100	135	270	675	1,100,000	400,000		
<b>SCOTS PINE - Estonia &amp; Lithuania</b>										
Select Structural		1,100	500	130	430	1,150	1,500,000	550,000		WCLIB
No.1	2" & wider	750	350	130	430	1,000	1,300,000	470,000		
No.2		650	300	130	430	900	1,100,000	400,000		
No.3		375	175	130	430	525	1,000,000	370,000		
Stud	2" & wider	525	225	130	430	575	1,000,000	370,000		
Construction	2" - 4" wide	750	325	130	430	1,100	1,100,000	400,000		
Standard		425	200	130	430	925	1,000,000	370,000		
Utility		200	100	130	430	600	900,000	330,000		
<b>SCOTS PINE - Finland</b>										
Select Structural		1,300	600	150	210	1,200	1,500,000	550,000	WCLIB	
No.1	2" & wider	950	425	150	210	1,100	1,400,000	510,000		
No.2		925	425	150	210	1,100	1,300,000	470,000		
No.3		525	250	150	210	625	1,200,000	440,000		
Stud	2" & wider	725	325	150	210	675	1,200,000	440,000		
Construction	2" - 4" wide	1,050	475	150	210	1,300	1,200,000	440,000		
Standard		600	275	150	210	1,100	1,100,000	400,000		
Utility		275	125	150	210	725	1,000,000	370,000		
<b>SCOTS PINE - Germany<sup>5</sup></b>										
Select Structural		1,200	550	160	395	1,200	1,600,000	580,000		WCLIB
No.1	2" & wider	800	375	160	395	1,050	1,400,000	510,000		
No.2		700	325	160	395	950	1,100,000	400,000		
No.3		400	175	160	395	550	1,000,000	370,000		
Stud	2" & wider	550	250	160	395	600	1,000,000	370,000		
Construction	2" - 4" wide	800	375	160	395	1,150	1,100,000	400,000		
Standard		450	200	160	395	975	1,000,000	370,000		
Utility		225	100	160	395	625	900,000	330,000		

only to be used with the 2005 NDS® and Wood Structural Design Data

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REFERENCE DESIGN VALUES

**Table 4F Reference Design Values for Non-North American Visually Graded Dimension Lumber (2" - 4" thick)<sup>1,3,4</sup>**

(Tabulated design values are for normal load duration and dry service conditions. See NDS 4.3 for a comprehensive description of design value adjustment factors.)

**USE WITH TABLE 4F ADJUSTMENT FACTORS**

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending F <sub>b</sub>	Tension parallel to grain F <sub>t</sub>	Shear parallel to grain F <sub>v</sub>	Compression perpendicular to grain F <sub>cL</sub>	Compression parallel to grain F <sub>c</sub>	Modulus of Elasticity		
							E	E <sub>min</sub>	
<b>SCOTS PINE - Sweden</b>									
Select Structural	2" & wider	1,350	600	120	410	1,200	1,700,000	620,000	WCLIB
No.1		825	375	120	410	1,000	1,500,000	550,000	
No.2		575	250	120	410	825	1,200,000	440,000	
No.3		325	150	120	410	475	1,100,000	400,000	
Stud	2" & wider	450	200	120	410	525	1,100,000	400,000	
Construction	2" - 4" wide	650	300	120	410	1,050	1,200,000	440,000	
Standard		375	175	120	410	850	1,100,000	400,000	
Utility		175	75	120	410	550	1,000,000	370,000	
<b>SILVER FIR (Abies alba) - Germany, NE France, &amp; Switzerland</b>									
Select Structural	2" & wider	950	425	125	400	1,100	1,500,000	550,000	WCLIB
No.1		725	325	125	400	975	1,400,000	510,000	
No.2		725	325	125	400	950	1,300,000	470,000	
No.3		425	200	125	400	550	1,100,000	400,000	
Stud	2" & wider	575	250	125	400	600	1,100,000	400,000	
Construction	2" - 4" wide	825	375	125	400	1,150	1,200,000	440,000	
Standard		475	200	125	400	975	1,100,000	400,000	
Utility		225	100	125	400	650	1,000,000	370,000	
<b>SOUTHERN PINE - Misiones Argentina</b>									
Select Structural	2" & wider	1,100	500	150	440	1,150	1,200,000	440,000	SPIB
No.1		775	350	150	440	1,000	1,100,000	400,000	
No.2		725	325	150	440	950	1,100,000	400,000	
No.3		425	200	150	440	550	900,000	330,000	
Stud	2" & wider	575	250	150	440	600	900,000	330,000	
Construction	2" - 4" wide	825	375	150	440	1,150	1,000,000	370,000	
Standard		475	200	150	440	975	900,000	330,000	
Utility		225	100	150	440	650	800,000	290,000	
<b>SOUTHERN PINE - Misiones Argentina, Free of Heart Center and Medium Grain Density</b>									
Select Structural	2" & wider	1,700	775	210	710	1,250	1,500,000	550,000	SPIB
No.1		1,150	525	210	710	1,150	1,500,000	550,000	
No.2		1,000	450	210	710	1,100	1,500,000	550,000	
No.3		575	250	210	710	650	1,400,000	510,000	
Stud	2" & wider	800	350	210	710	700	1,400,000	510,000	
Construction	2" - 4" wide	1,150	525	210	710	1,350	1,400,000	510,000	
Standard		650	300	210	710	1,150	1,300,000	470,000	
Utility		300	125	210	710	750	1,200,000	440,000	

- LUMBER DIMENSIONS.** Tabulated design values are applicable to lumber that will be used under dry conditions such as in most covered structures. For 2" to 4" thick lumber the DRY dressed sizes shall be used (see Table 1A) regardless of the moisture content at the time of manufacture or use. In calculating design values, the natural gain in strength and stiffness that occurs as lumber dries has been taken into consideration as well as the reduction in size that occurs when unseasoned lumber shrinks. The gain in the load carrying capacity due to increased strength and stiffness resulting from drying more than offsets the design effect of size reductions due to shrinkage.
- Design values are applicable only for 2x4 dimensional lumber and shall not be multiplied by the size factor adjustment.
- Specific Gravity, G, values for Non-North American Species are provided below in lieu of providing G values in NDS Table 11.3.2A

Species or Species Combination	Specific Gravity	Species or Species Combination	Specific Gravity
Austrian Spruce - Austria & The Czech Republic	0.43	Scots Pine - Austria, The Czech Republic, Romania, & the Ukraine	0.50
Douglas Fir/European Larch - Austria, The Czech Republic, & Bavaria	0.48	Scots Pine - Estonia & Lithuania	0.45
Montane Pine - South Africa	0.45	Scots Pine - Finland	0.48
Norway Spruce - Estonia & Lithuania	0.43	Scots Pine - Germany*	0.53
Norway Spruce - Finland	0.42	Scots Pine - Sweden	0.47
Norway Spruce - Germany, NE France, & Switzerland	0.42	Silver Fir (Abies alba) - Germany, NE France, & Switzerland	0.43
Norway Spruce - Romania & the Ukraine	0.38	Southern Pine - Misiones Argentina, Free of Heart Center and Medium Grain Density	0.54
Norway Spruce - Sweden	0.42	Southern Pine - Misiones Argentina	0.45

\* See footnote 5.

- When individual species or species groups are combined, the design values to be used for the combination shall be the lowest design values for each individual species or species group for each design property.
- Does not include states of Baden-Wurttemberg and Saarland.



## Table 5A Adjustment Factors

### Volume Factor, $C_V$

Tabulated bending design values for loading perpendicular to wide faces of laminations,  $F_{bx}$ , for structural glued laminated bending members shall be multiplied by the following volume factor:

$$C_V = (21/L)^{1/x} (12/d)^{1/x} (5.125/b)^{1/x} \leq 1.0$$

where:

- L = length of bending member between points of zero moment, ft
- d = depth of bending member, in.
- b = width (breadth) of bending member, in. For multiple piece width, b = width of widest piece in the layup. Thus  $b \leq 10.75$ ".
- x = 20 for Southern Pine
- x = 10 for all other species

The volume factor shall not apply simultaneously with the beam stability factor (see 5.3.6). Therefore, the lesser of these adjustment factors shall apply.

### Flat Use Factor, $C_{fu}$

Tabulated bending design values for loading parallel to wide faces of laminations,  $F_{by}$ , shall be multiplied by the following flat use factors when the member dimension parallel to wide faces of laminations is less than 12":

Flat Use Factors,  $C_{fu}$

Member dimension parallel to wide faces of laminations	$C_{fu}$
10-3/4" or 10-1/2"	1.01
8-3/4" or 8-1/2"	1.04
6-3/4"	1.07
5-1/8" or 5"	1.10
3-1/8" or 3"	1.16
2-1/2"	1.19

### Wet Service Factor, $C_M$

When structural glued laminated timber is used where moisture content will be 16% or greater, design values shall be multiplied by the appropriate wet service factors from the following table:

Wet Service Factors,  $C_M$

$F_b$	$F_t$	$F_v$	$F_{c\perp}$	$F_c$	E and $E_{min}$
0.8	0.8	0.875	0.53	0.73	0.833

4

REFERENCE DESIGN VALUES

**Table 5A Reference Design Values for Structural Glued Laminated Softwood Timber**

(Members stressed primarily in bending) (Tabulated design values are for normal load duration and dry service conditions. See NDS 5.3 for a comprehensive description of design value adjustment factors.)

**Use with Table 5A Adjustment Factors**

Stress Class	Bending About X-X Axis Loaded Perpendicular to Wide Faces of Laminations				Bending About Y-Y Axis Loaded Parallel to Wide Faces of Laminations				Axially Loaded		Fasteners		
	Extreme Fiber in Bending		Compression Perpendicular to Grain (Horizontal)	Shear Parallel to Grain (Horizontal)	Modulus of Elasticity for Beam and Column Stability	Extreme Fiber in Bending	Compression Perpendicular to Grain	Shear Parallel to Grain (Horizontal)	Modulus of Elasticity for Beam and Column Stability	Tension Parallel to Grain		Compression Parallel to Grain	Modulus of Elasticity
	Tension Zone Stressed in Tension (Positive Bending)	Compression Zone Stressed in Tension (Negative Bending)											
	$F_{bx}^+$ (psi)	$F_{bx}^-$ (psi)	$F_{cLx}$ (psi)	$F_{vx}^{(4)}$ (psi)	$E_x$ ( $10^6$ psi)	$F_{by}$ (psi)	$F_{cLy}$ (psi)	$F_{vy}^{(4)(5)}$ (psi)	$E_y$ ( $10^6$ psi)	$F_t$ (psi)	$F_c$ (psi)	$E_{axial}$ ( $10^6$ psi)	
16F-1.3E	1600	925	315	195	1.3	800	315	170	1.1	675	925	1.2	
20F-1.5E	2000	1100	425	210 <sup>(6)</sup>	1.5	800	315	185	1.2	725	925	1.3	
24F-1.7E	2400	1450	500	210 <sup>(6)</sup>	1.7	1050	315	185	1.3	775	1000	1.4	
24F-1.8E	2400	1450 <sup>(2)</sup>	650	265 <sup>(3)</sup>	1.8	1450	560	230 <sup>(3)</sup>	1.6	1100	1600	1.7	
26F-1.9E <sup>(7)</sup>	2600	1950	650	265 <sup>(3)</sup>	1.9	1600	560	230 <sup>(3)</sup>	1.6	1150	1600	1.7	
28F-2.1E SP <sup>(7)</sup>	2800	2300	740	300	2.1 <sup>(9)</sup>	1600	650	260	1.7	1250	1750	1.7	
30F-2.1E SP <sup>(7)(8)</sup>	3000	2400	740	300	2.1 <sup>(9)</sup>	1750	650	260	1.7	1250	1750	1.7	

- For balanced layups,  $F_{bx}^+$  shall be equal to  $F_{bx}^-$  for the stress class. Designer shall specify when balanced layup is required.
- Negative bending stress,  $F_{bx}^-$ , is permitted to be increased to 1,850 psi for Douglas Fir and to 1,950 psi for Southern Pine for specific combinations. Designer shall specify when these increased stresses are required.
- For structural glued laminated timber of Southern Pine, the basic shear design values,  $F_{vx}$  and  $F_{vy}$ , are permitted to be increased to 300 psi and 260 psi, respectively.
- The design value for shear,  $F_{vx}$ , and  $F_{vy}$  shall be decreased by multiplying by a factor of 0.72 for non-prismatic members, notched members, and for all members subject to impact or cyclic loading. The reduced design value shall be used for design of members at connections that transfer shear by mechanical fasteners (NDS 3.4.3.3). The reduced design value shall also be used for determination of design values for radial tension (NDS 5.2.2).
- Design values are for timbers with laminations made from a single piece of lumber across the width or multiple pieces that have been edge bonded. For timbers manufactured from multiple piece laminations (across width) that are not edge bonded, value shall be multiplied by 0.4 for members with 5, 7, or 9 laminations or by 0.5 for all other members. This reduction shall be cumulative with the adjustment in footnote (4).
- Certain Southern Pine combinations may contain lumber with wane. If lumber with wane is used, the design value for shear parallel to grain,  $F_{vx}$ , shall be multiplied by 0.67 if wane is allowed on both sides. If wane is limited to one side,  $F_{vx}$  shall be multiplied by 0.83. This reduction shall be cumulative with the adjustment in footnote (4).
- 26F, 28F, and 30F beams are not produced by all manufacturers, therefore, availability may be limited. Contact supplier or manufacturer for details.
- 30F combinations are restricted to a maximum 6" nominal width.
- For 28F and 30F members with more than 15 laminations,  $E_x = 2.0$  million psi and  $E_{x, min} = 1.04$  million psi.
- For structural glued laminated timber of Southern Pine, specific gravity for fastener design is permitted to be increased to 0.55.

Design values in this table represent design values for groups of similar structural glued laminated timber combinations. Higher design values for some properties may be obtained by specifying a particular combination listed in Table 5A Expanded. Design values are for members with 4 or more laminations. For 2 and 3 lamination members, see Table 5B. Some stress classes are not available in all species. Contact structural glued laminated timber manufacturer for availability.

**Table 5A Expanded - Reference Design Values for Structural Glued Laminated Softwood Timber Combinations<sup>1</sup>**

(Members stressed primarily in bending) (Tabulated design values are for normal load duration and dry service conditions.) Table 5A Expanded is an expanded list of structural glued laminated timber combinations from AITC 117 and APA-EWS Y117 that meet the requirements of each stress class in the new structural glued laminated timber stress class system. Table 5A Expanded is provided to allow easy conversion from the old combination symbols system to the new stress class system.

**Use with Table 5A Adjustment Factors**

Combination Symbol	Species Outer/Core	Bending About X-X Axis (Loaded Perpendicular to Wide Faces of Laminations)										Bending About Y-Y Axis (Loaded Parallel to Wide Faces of Laminations)					Axially Loaded			Fasteners			
		Extreme Fiber in Bending		Compression Perpendicular to Grain		F <sub>vx</sub> <sup>(3)</sup> (psi)	E <sub>x</sub> (10 <sup>6</sup> psi)	E <sub>x</sub> min (10 <sup>6</sup> psi)	Modulus of Elasticity for Beam and Column Stability	Extreme Fiber in Bending	Compression Perpendicular to Grain	Shear Parallel to Grain (Horizontal)	Modulus of Elasticity	Modulus of Elasticity for Beam and Column Stability	F <sub>cy</sub> (psi)	F <sub>vy</sub> <sup>(4)</sup> (psi)	E <sub>y</sub> (10 <sup>6</sup> psi)	E <sub>y</sub> min (10 <sup>6</sup> psi)	Tension Parallel to Grain	Compression Parallel to Grain	Modulus of Elasticity	Specific Gravity for Fastener Design	G
		Tension Zone Stressed in	Compression Zone Stressed in	Tension Face	Compression Face																		
<b>16F-1.3E</b>		1,600	925	1,600	315	195	1.3	0.87	800	315	170	1.1	0.57	675	925	1.2	0.42						
16F-V6	DF/DF	1,600	1,600	560	560	265	1.5	0.78	1,450	560	230	1.5	0.78	900	1,550	1.6	0.5	0.5	0.5				
16F-E2	HF/HF	1,600	1,050	375	375	215	1.3	0.87	1,200	375	190	1.3	0.67	825	1,200	1.4	0.43	0.43	0.43				
16F-E3	DF/DF	1,600	1,200	560	560	215	1.6	0.83	1,450	560	230	1.5	0.78	900	1,600	1.6	0.5	0.5	0.5				
16F-E6	DF/DF	1,600	1,600	560	560	265	1.6	0.83	1,550	560	230	1.5	0.78	975	1,600	1.6	0.5	0.5	0.5				
16F-E7	HF/HF	1,600	1,600	375	375	215	1.4	0.73	1,450	375	190	1.4	0.73	1,000	1,450	1.5	0.43	0.43	0.43				
16F-V2	SP/SP	1,600	1,350	650	650	300	1.4	0.73	1,450	650	260	1.4	0.73	975	1,350	1.5	0.55	0.55	0.55				
16F-V3	SP/SP	1,600	1,450	740	740	300	1.4	0.73	1,450	650	260	1.4	0.73	975	1,400	1.4	0.55	0.55	0.55				
16F-V5	SP/SP	1,600	1,600	650	650	300	1.4	0.73	1,750	650	260	1.4	0.73	1,000	1,500	1.5	0.55	0.55	0.55				
16F-E1	SP/SP	1,600	1,250	650	650	300	1.6	0.83	1,750	650	260	1.5	0.78	1,050	1,550	1.6	0.55	0.55	0.55				
16F-E3	SP/SP	1,600	1,600	650	650	300	1.6	0.83	1,750	650	260	1.5	0.78	1,100	1,600	1.6	0.55	0.55	0.55				
<b>20F-1.5E</b>		2,000	1,100	425	425	210	1.5	0.78	800	315	185	1.2	0.62	725	925	1.3	0.42						
20F-V7	DF/DF	2,000	1,450	650	650	265	1.6	0.83	1,450	560	230	1.5	0.78	975	1,550	1.6	0.5	0.5	0.5				
20F-V3	DF/DF	2,000	2,000	650	650	265	1.6	0.83	1,450	560	230	1.6	0.83	1,000	1,600	1.6	0.5	0.5	0.5				
20F-V9	HF/HF	2,000	2,000	500	500	215	1.5	0.78	1,350	375	190	1.4	0.73	975	1,400	1.5	0.43	0.43	0.43				
20F-V12	AC/AC	2,000	1,400	560	560	265	1.5	0.78	1,250	470	230	1.4	0.73	900	1,500	1.4	0.46	0.46	0.46				
20F-V13	AC/AC	2,000	2,000	560	560	265	1.5	0.78	1,250	470	230	1.4	0.73	925	1,550	1.5	0.46	0.46	0.46				
20F-E2	HF/HF	2,000	1,400	500	500	215	1.6	0.73	1,200	375	190	1.4	0.73	925	1,350	1.5	0.43	0.43	0.43				
20F-E3	DF/DF	2,000	1,200	560	560	265	1.7	0.83	1,450	560	230	1.6	0.83	1,000	1,600	1.7	0.5	0.5	0.5				
20F-E6	DF/DF	2,000	2,000	560	560	265	1.7	0.88	1,550	560	230	1.6	0.83	1,100	1,650	1.7	0.5	0.5	0.5				
20F-E7	HF/HF	2,000	2,000	500	500	215	1.6	0.83	1,450	375	190	1.4	0.73	1,050	1,450	1.5	0.43	0.43	0.43				
20F-V2	SP/SP	2,000	1,550	740	650	300	1.5	0.78	1,450	650	260	1.4	0.73	975	1,350	1.5	0.55	0.55	0.55				
20F-V3	SP/SP	2,000	1,450	650	650	300	1.5	0.78	1,750	650	260	1.4	0.73	1,050	1,400	1.5	0.55	0.55	0.55				
20F-V5	SP/SP	2,000	2,000	740	740	300	1.6	0.83	1,450	650	260	1.4	0.73	1,050	1,500	1.5	0.55	0.55	0.55				
20F-E1	SP/SP	2,000	1,250	650	650	300	1.7	0.88	1,750	650	260	1.5	0.78	1,050	1,550	1.6	0.55	0.55	0.55				
20F-E3	SP/SP	2,000	2,000	650	650	300	1.7	0.88	1,900	650	260	1.5	0.78	1,150	1,650	1.6	0.55	0.55	0.55				
<b>24F-1.7E</b>		2,400	1,450	500	500	210	1.7	0.88	1,050	315	185	1.3	0.67	775	1,000	1.4	0.42						
24F-V5	DF/HF	2,400	1,600	650	650	215	1.7	0.88	1,200	375	190	1.5	0.78	1,150	1,450	1.6	0.5	0.43	0.43				
24F-V10	DF/HF	2,400	2,400	650	650	215	1.8	0.93	1,450	375	190	1.5	0.78	1,100	1,550	1.6	0.5	0.43	0.43				
24F-E11	HF/HF	2,400	2,400	500	500	215	1.8	0.93	1,550	375	190	1.5	0.78	1,150	1,550	1.6	0.43	0.43	0.43				
24F-E15	HF/HF	2,400	1,600	500	500	215	1.8	0.93	1,200	375	190	1.5	0.78	975	1,500	1.6	0.43	0.43	0.43				
24F-V1	SP/SP	2,400	1,750	740	650	300	1.7	0.88	1,450	650	260	1.5	0.78	1,100	1,550	1.6	0.55	0.55	0.55				
24F-V4 <sup>(5)</sup>	SP/SP	2,400	1,450	740	650	210	1.7	0.88	1,050	470	185	1.3	0.67	875	1,000	1.5	0.55	0.55	0.55				
24F-V5	SP/SP	2,400	2,400	740	740	300	1.7	0.88	1,750	650	260	1.5	0.78	1,150	1,650	1.6	0.55	0.55	0.55				



## Footnotes to Expanded Table 5A

1. The combinations in this table are applicable to members consisting of 4 or more laminations and are intended primarily for members stressed in bending due to loads applied perpendicular to the wide faces of the laminations. However, design values are tabulated for loading both perpendicular and parallel to the wide faces of the laminations. For combinations and design values applicable to members loaded primarily axially or parallel to the wide faces of the laminations, see Table 5B. For members of 2 or 3 laminations, see Table 5B.
2. The tabulated design values in this column, for bending about the X-X axis ( $F_{bx}$ ), require the use of special tension laminations. If these special tension laminations are omitted, value shall be multiplied by 0.75 for members greater than or equal to 15" in depth or by 0.85 for members less than 15" in depth.
3. The design value for shear,  $F_{vx}$  and  $F_{vy}$ , shall be decreased by multiplying by a factor of 0.72 for non-prismatic members, notched members, and for all members subject to impact or cyclic loading. The reduced design value shall be used for design of members at connections (NDS 3.4.3.3) that transfer shear by mechanical fasteners. The reduced design value shall also be used for determination of design values for radial tension (NDS 5.2.2).
4. Design values are for timbers with laminations made from a single piece of lumber across the width or multiple pieces that have been edge bonded. For timber manufactured from multiple piece laminations (across width) that are not edge-bonded, value shall be multiplied by 0.4 for members with 5, 7, or 9 laminations or by 0.5 for all other members. This reduction shall be cumulative with the adjustment in footnote (3).
5. This combination may contain lumber with wane. If lumber with wane is used, the design value for shear parallel to grain,  $F_{vx}$  shall be multiplied by 0.67 if wane is allowed on both sides. If wane is limited to one side,  $F_{vx}$  shall be multiplied by 0.83. This reduction shall be cumulative with the adjustment in footnote (3).
6. 26F, 28F, and 30F beams are not produced by all manufacturers, therefore, availability may be limited. Contact supplier or manufacturer for details.
7. 30F combinations are restricted to a maximum 6" nominal width.
8. For 28F and 30F members with more than 15 laminations,  $E_x = 2.0$  million psi and  $E_{x\ min} = 1.04$  million psi.

## Table 5B Adjustment Factors

### Volume Factor, $C_v$

Tabulated bending design values for loading perpendicular to wide faces of laminations,  $F_{bx}$ , for structural glued laminated bending members shall be multiplied by the following volume factor:

$$C_v = (21/L)^{1/x} (12/d)^{1/x} (5.125/b)^{1/x} \leq 1.0$$

where:

- L = length of bending member between points of zero moment, ft
- d = depth of bending member, in.
- b = width (breadth) of bending member, in. For multiple piece width layups, b = width of widest piece in the layup. Thus  $b \leq 10.75$ ".
- x = 20 for Southern Pine
- x = 10 for all other species

The volume factor shall not apply simultaneously with the beam stability factor (see 5.3.6). Therefore, the lesser of these adjustment factors shall apply.

### Wet Service Factor, $C_M$

When structural glued laminated timber is used where moisture content will be 16% or greater, design values shall be multiplied by the appropriate wet service factors from the following table:

Wet Service Factors,  $C_M$

$F_b$	$F_t$	$F_v$	$F_{c\perp}$	$F_c$	E and $E_{min}$
0.8	0.8	0.875	0.53	0.73	0.833

### Flat Use Factor, $C_{fu}$

Tabulated bending design values for loading parallel to wide faces of laminations,  $F_{by}$ , shall be multiplied by the following flat use factors when the member dimension parallel to wide faces of laminations is less than 12":

Flat Use Factors,  $C_{fu}$

Member dimension parallel to wide faces of laminations	$C_{fu}$
10-3/4" or 10-1/2"	1.01
8-3/4" or 8-1/2"	1.04
6-3/4"	1.07
5-1/8" or 5"	1.10
3-1/8" or 3"	1.16
2-1/2"	1.19

**Table 5B Reference Design Values for Structural Glued Laminated Softwood Timber**

(Members stressed primarily in axial tension or compression)<sup>1,2</sup> (Tabulated design values are for normal load duration and dry service conditions. See NDS 5.3 for a comprehensive description of design value adjustment factors.)

Use with Table 5B Adjustment Factors

Identification Number	Species	Grade	All Loading			Axially Loaded			Bending about Y-Y Axis				Bending About X-X Axis	
			Modulus of Elasticity (10 <sup>6</sup> psi)	Modulus of Elasticity for Beam and Column Stability E <sub>min</sub> (10 <sup>6</sup> psi)	F <sub>c,L</sub> (psi)	Tension Parallel to Grain F <sub>t</sub> (psi)	Compression Parallel to Grain		Loaded Parallel to Wide Faces of Laminations		Shear Parallel to Grain <sup>(1)(2)(3)</sup>		Loaded Perpendicular to Wide Faces of Laminations	
							2 or More Laminations F <sub>c</sub> (psi)	4 or More Laminations F <sub>c</sub> (psi)	2 or 3 Laminations F <sub>c</sub> (psi)	Bending	Bending	Shear Parallel to Grain <sup>(4)</sup>	Shear Parallel to Grain <sup>(3)</sup>	
<b>Visually Graded Western Species</b>														
1	DF	L3	1.5	0.78	560	900	1550	1200	1450	1250	1000	230	1250	265
2	DF	L2	1.6	0.83	560	1250	1950	1600	1800	1600	1300	230	1700	265
3	DF	L2D	1.9	0.98	650	1450	2300	1850	2100	1850	1550	230	2000	265
4	DF	L1CL	1.9	0.98	590	1400	2100	1900	2200	2000	1650	230	1900	265
5	DF	L1D	2.0	1.04	650	1600	2400	2100	2400	2100	1800	230	2200	265
14	HF	L3	1.3	0.67	375	800	1100	975	1200	1050	850	190	1100	215
15	HF	L2	1.4	0.73	375	1050	1350	1300	1500	1350	1100	190	1450	215
16	HF	L1	1.6	0.83	375	1200	1500	1450	1750	1550	1300	190	1600	215
17	HF	L1D	1.7	0.88	500	1400	1750	1700	2000	1850	1550	190	1900	215
22 <sup>(6)</sup>	SW	L3	1.0	0.52	315	525	850	675	800	700	550	170	725	195
69	AC	L3	1.2	0.62	470	725	1150	1100	1100	975	775	230	1000	265
70	AC	L2	1.3	0.67	470	975	1450	1400	1400	1250	1000	230	1350	265
71	AC	L1D	1.6	0.83	560	1250	1900	1900	1850	1650	1400	230	1700	265
72	AC	L1S	1.6	0.83	560	1250	1900	1900	1850	1650	1400	230	1900	265
<b>E-Rated Western Species</b>														
27	DF	1.9E2	1.8	0.93	560	900	1750	1200	1450	1250	1000	230	1250	265
28	DF	2.1E2	2.0	1.04	650	1100	2000	1400	1650	1450	1150	230	1500	265
29	DF	2.3E2	2.2	1.14	650	1250	2250	1550	1900	1650	1350	230	1700	265
30	DF	1.9E6	1.8	0.93	560	1550	2100	1700	2400	2400	2100	230	1800	265
31	DF	2.1E6	2.0	1.04	650	1800	2400	1950	2400	2400	2400	230	2100	265
32	DF	2.3E6	2.2	1.14	650	1800	2400	2200	2400	2400	2400	230	2400	265
62	DF	2.2E2	2.1	1.09	650	1150	1850	1500	1800	1550	1250	230	1800	265
63	DF	2.2E6	2.1	1.09	650	1950	2300	2000	2400	2400	2400	230	2200	265
33	HF	1.9E2	1.5	0.78	375	800	1050	950	1200	1050	850	190	1100	215
34	HF	1.9E2	1.8	0.93	500	900	1500	1200	1450	1250	1000	190	1300	215
35	HF	2.1E2	2.0	1.04	500	1100	1550	1400	1650	1450	1150	190	1850	215
36	HF	1.6E4	1.5	0.78	375	1200	1350	1350	2100	1900	1700	190	1400	215
37	HF	1.9E6	1.8	0.93	500	1550	1950	1700	2400	2400	2100	190	1800	215
38	HF	2.1E6	2.0	1.04	500	1800	2400	1950	2400	2400	2400	190	2100	215
39 <sup>(6)</sup>	SW	1.6E2	1.5	0.78	315	800	1200	950	1200	1050	850	170	1100	195
40 <sup>(6)</sup>	SW	1.9E2	1.8	0.93	315	900	1500	1200	1450	1250	1000	170	1250	195
41 <sup>(6)</sup>	SW	2.1E2	2.0	1.04	315	1100	1750	1400	1650	1450	1150	170	1550	195
42 <sup>(6)</sup>	SW	1.6E4	1.5	0.78	315	1200	1550	1350	2100	1900	1700	170	1400	195
43 <sup>(6)</sup>	SW	1.9E6	1.8	0.93	315	1550	1950	1700	2400	2400	2100	170	1800	195
44 <sup>(6)</sup>	SW	2.1E6	2.0	1.04	315	1800	2100	1950	2400	2400	2400	170	2100	195

**Table 5B Reference Design Values for Structural Glued Laminated Softwood Timber**

(Members stressed primarily in axial tension or compression)<sup>1,2</sup> (Tabulated design values are for normal load duration and dry service conditions. See NDS 5.3 for a comprehensive description of design value adjustment factors.)

**Use with Table 5B Adjustment Factors**

Identification Number	Species	Grade	All Loading			Axially Loaded			Bending about Y-Y Axis Loaded Parallel to Wide Faces of Laminations			Bending About X-X Axis Loaded Perpendicular to Wide Faces of Laminations		
			Modulus of Elasticity E (10 <sup>6</sup> psi)	Modulus of Elasticity and Column Stability E <sub>min</sub> (10 <sup>6</sup> psi)	Compression Perpendicular to Grain F <sub>cL</sub> (psi)	Tension Parallel to Grain F <sub>t</sub> (psi)	Compression Parallel to Grain		Bending	Shear Parallel to Grain <sup>(1)(2)(3)</sup>		Bending <sup>(4)</sup>	Shear Parallel to Grain <sup>(3)</sup>	
							4 or More Laminations F <sub>c</sub> (psi)	2 or 3 Laminations F <sub>c</sub> (psi)		F <sub>vy</sub> (psi)	F <sub>vx</sub> (psi)			
<b>Visually Graded Southern Pine</b>														
47	SP	N2M14	1.4	0.73	650	1200	1900	1150	1750	1550	1300	260	1400	300
47	1:10	SP	N2M10	1.4	650	1150	1700	1150	1750	1550	1300	260	1400	300
47	1:8	SP	N2M	1.4	650	1000	1500	1150	1600	1550	1300	260	1350	300
48	SP	N2D14	1.7	0.88	740	1400	2200	1350	1800	1800	1500	260	1600	300
48	1:10	SP	N2D10	1.7	740	1350	2000	1350	2000	1800	1500	260	1600	300
48	1:8	SP	N2D	1.7	740	1150	1750	1350	1850	1800	1500	260	1600	300
49	SP	N1M16	1.7	0.88	650	1350	2100	1450	1950	1750	1500	260	1800	300
49	1:12	SP	N1M12	1.7	650	1300	1900	1450	1950	1750	1500	260	1750	300
49	1:10	SP	N1M	1.7	650	1150	1700	1450	1850	1750	1500	260	1550	300
50	SP	N1D14	1.9	0.98	740	1550	2300	1700	2300	2100	1750	260	2100	300
50	1:12	SP	N1D12	1.9	740	1550	2200	1700	2300	2100	1750	260	2100	300
50	1:10	SP	N1D	1.9	740	1350	2000	1700	2100	2100	1750	260	1800	300
<b>E-Rated Southern Pine</b>														
54	SP	2.1E2	2.0	1.04	740	1100	2300	1400	1650	1450	1150	260	1500	300
55	SP	2.3E2	2.2	1.14	740	1250	2400	1550	1900	1650	1350	260	1700	300
56	SP	1.9E6	1.8	0.93	650	1550	1850	1700	2400	2400	2100	260	1800	300
57	SP	2.1E6	2.0	1.04	740	1800	2300	1950	2400	2400	2400	260	2100	300
58	SP	2.3E6	2.2	1.14	740	1800	2400	2200	2400	2400	2400	260	2400	300

- For members with 2 or 3 laminations, the shear design value for transverse loads parallel to the wide faces of the laminations, F<sub>vy</sub>, shall be reduced by multiplying by a factor of 0.84 or 0.95, respectively.
- The shear design value for transverse loads applied parallel to the wide faces of the laminations, F<sub>vy</sub>, shall be multiplied by 0.4 for members with 5, 7, or 9 laminations manufactured from multiple piece laminations (across width) that are not edge bonded. The shear design value, F<sub>vy</sub>, shall be multiplied by 0.5 for all other members manufactured from multiple piece laminations with unbonded edge joints. This reduction shall be cumulative with the adjustment in footnote (1) and (3).
- The design value for shear, F<sub>vx</sub> and F<sub>vy</sub>, shall be decreased by multiplying by a factor of 0.72 for non-prismatic members, notched members, and for all members subject to impact or cyclic loading. The reduced design value shall be used for design of members at connections (NDS 3.4.3.3) that transfer shear by mechanical fasteners. The reduced design value shall also be used for determination of design values for radial tension (NDS 5.2.2).
- Tabulated design values are for members without special tension laminations. If special tension laminations are used, the design value for bending, F<sub>bx</sub>, shall be permitted to be increased by multiplying by 1.18. This factor shall not be applied cumulatively with the adjustment in footnote (5).
- For members greater than 15" deep and without special tension laminations, the bending design value, F<sub>bx</sub>, shall be reduced by multiplying by a factor of 0.88. This factor shall not be applied cumulatively with the adjustment in footnote (4).
- When Western Cedars, Western Cedars (North), Western Woods, and Redwood (open grain) are used in combinations for Softwood Species (SW), the design value for E shall be reduced by 100,000 psi and E<sub>min</sub> shall be reduced by 50,000 psi. When Coast Sitka Spruce, Coast Species, Western White Pine, and Eastern White Pine are used in combinations for Softwood Species (SW) tabulated design values for shear parallel to grain, F<sub>vx</sub> and F<sub>vy</sub>, shall be reduced by 10 psi, before applying any other adjustments.



## Table 5C Adjustment Factors

### Volume Factor, $C_V$

Tabulated bending design values for loading perpendicular to wide faces of laminations,  $F_{bx}$ , for structural glued laminated bending members shall be multiplied by the following volume factor:

$$C_V = (21/L)^{1/x} (12/d)^{1/x} (5.125/b)^{1/x} \leq 1.0$$

where:

- L = length of bending member between points of zero moment, ft
- d = depth of bending member, in.
- b = width (breadth) of bending member, in. For multiple piece width layups, b = width of widest piece in the layup. Thus  $b \leq 10.75$ ".
- x = 20 for Southern Pine
- x = 10 for all other species

The volume factor shall not apply simultaneously with the beam stability factor (see 5.3.6). Therefore, the lesser of these adjustment factors shall apply.

### Wet Service Factor, $C_M$

When structural glued laminated timber is used where moisture content will be 16% or greater, design values shall be multiplied by the appropriate wet service factors from the following table:

$F_b$	$F_t$	$F_v$	$F_{c\perp}$	$F_c$	E and $E_{min}$
0.8	0.8	0.875	0.53	0.73	0.833

### Flat Use Factor, $C_{fu}$

Tabulated bending design values for loading parallel to wide faces of laminations,  $F_{by}$ , shall be multiplied by the following flat use factors when the member dimension parallel to wide faces of laminations is less than 12":

Flat Use Factors,  $C_{fu}$

Member dimension parallel to wide faces of laminations	$C_{fu}$
10-3/4" or 10-1/2"	1.01
8-3/4" or 8-1/2"	1.04
6-3/4"	1.07
5-1/8" or 5"	1.10
3-1/8" or 3"	1.16
2-1/2"	1.19

**Table 5C Reference Design Values for Structural Glued Laminated Hardwood Timber**

(Members stressed primarily in bending)<sup>1</sup>: (Tabulated design values are for normal load duration and dry service conditions. See NDS 5.3 for a comprehensive description of design value adjustment factors.)

**Use with Table 5C Adjustment Factors**

Combination Symbol	Bending About X-X Axis Loaded Perpendicular to Wide Faces of Laminations				Bending About Y-Y Axis Loaded Parallel to Wide Faces of Laminations				Axially Loaded		Fasteners <sup>(3)</sup>				
	Extreme Fiber in Bending	Compression Perpendicular to Grain	Shear Parallel to Grain (Horizontal)	Modulus of Elasticity	Extreme Fiber in Bending	Compression Perpendicular to Grain	Shear Parallel to Grain (Horizontal)	Modulus of Elasticity	Tension Parallel to Grain	Compression Parallel to Grain		Modulus of Elasticity			
													F <sub>bx</sub> <sup>+</sup> (psi)	F <sub>bx</sub> <sup>-</sup> (psi)	F <sub>vx</sub> (psi)
<b>Visually Graded Hardwoods</b>															
12F-V1	1,200	600	285	125	1.2	0.62	1,050	285	110	1.0	0.52	600	800	1.0	0.39
12F-V2	1,200	1,200	285	125	1.2	0.62	1,050	285	110	1.1	0.57	625	860	1.1	0.39
14F-V1	1,400	700	405	155	1.3	0.67	1,250	405	135	1.1	0.57	700	950	1.1	0.45
14F-V2	1,400	700	590	180	1.3	0.67	1,450	590	160	1.1	0.57	750	1,200	1.1	0.53
14F-V3	1,400	1,400	405	155	1.3	0.67	1,250	405	135	1.1	0.57	725	950	1.1	0.45
14F-V4	1,400	1,400	590	180	1.3	0.67	1,450	590	160	1.1	0.57	775	1,200	1.1	0.53
16F-V1	1,600	800	590	180	1.4	0.73	1,400	590	160	1.2	0.62	800	1,200	1.2	0.53
16F-V2	1,600	800	835	200	1.5	0.78	1,700	835	175	1.3	0.67	875	1,250	1.3	0.63
16F-V3	1,600	1,600	590	180	1.4	0.73	1,400	590	160	1.2	0.62	850	1,200	1.2	0.53
16F-V4	1,600	1,600	835	200	1.6	0.83	1,700	835	175	1.3	0.67	900	1,300	1.3	0.63
20F-V1	2,000	1,000	835	200	1.7	0.88	1,700	835	175	1.4	0.73	975	1,400	1.4	0.63
20F-V2	2,000	2,000	835	200	1.7	0.88	1,700	835	175	1.4	0.73	1,000	1,400	1.4	0.63
<b>E-Rated Hardwoods</b>															
16F-E1	1,600	800	440	125	1.4	0.73	1,250	285	110	1.2	0.62	825	975	1.2	0.39
16F-E2	1,600	1,600	440	125	1.4	0.73	1,400	285	110	1.2	0.62	900	1,000	1.2	0.39
20F-E1	2,000	1,000	590	155	1.6	0.83	1,350	405	135	1.3	0.67	950	1,050	1.3	0.45
20F-E2	2,000	2,000	590	155	1.6	0.83	1,600	405	135	1.3	0.67	1,050	1,100	1.3	0.45
24F-E1	2,400	1,200	770	180	1.8	0.93	1,550	590	160	1.5	0.78	1,050	1,400	1.5	0.53
24F-E2	2,400	2,400	770	180	1.8	0.93	1,650	590	160	1.5	0.78	1,050	1,400	1.5	0.53
24F-E3 YP	2,400	1,200	590	155	1.8	0.93	1,450	405	135	1.5	0.78	975	1,200	1.5	0.45
24F-E4 RM	2,400	1,200	895	220	1.8	0.93	1,650	710	195	1.6	0.83	1,050	1,350	1.6	0.53
24F-E5 RO	2,400	1,200	1,075	235	1.8	0.93	1,700	900	205	1.5	0.78	1,100	1,450	1.5	0.63

1. Design values in this table were excepted from AITC 119-96 *Standard Specifications for Structural Glued Laminated Timber of Hardwood Species*. Design values are applicable to members with 4 or more laminations. For 2 and 3 lamination members see Table 5D.  
 2. Design values are for timbers with laminations made from a single piece of lumber across the width or multiple pieces that have been edge bonded. For timbers manufactured from multiple piece laminations (across width) that are not edge bonded, value shall be multiplied by 0.4 for members with 5, 7, or 9 laminations or by 0.5 for all other members.  
 3. Fastener values are for groups of hardwood species permitted in each combination. If actual species is known, values for that species are permitted to be used.

## Table 5D Adjustment Factors

### Volume Factor, $C_V$

Tabulated bending design values for loading perpendicular to wide faces of laminations,  $F_{bx}$ , for structural glued laminated bending members shall be multiplied by the following volume factor:

$$C_V = (21/L)^{1/x} (12/d)^{1/x} (5.125/b)^{1/x} \leq 1.0$$

where:

- L = length of bending member between points of zero moment, ft
- d = depth of bending member, in.
- b = width (breadth) of bending member, in. For multiple piece width layups, b = width of widest piece in the layup. Thus  $b \leq 10.75$ ".
- x = 20 for Southern Pine
- x = 10 for all other species

The volume factor shall not apply simultaneously with the beam stability factor (see 5.3.6). Therefore, the lesser of these adjustment factors shall apply.

### Wet Service Factor, $C_M$

When structural glued laminated timber is used where moisture content will be 16% or greater, design values shall be multiplied by the appropriate wet service factors from the following table:

$F_b$	$F_t$	$F_v$	$F_{c\perp}$	$F_c$	E and $E_{min}$
0.8	0.8	0.875	0.53	0.73	0.833

### Flat Use Factor, $C_{fu}$

Tabulated bending design values for loading parallel to wide faces of laminations,  $F_{by}$ , shall be multiplied by the following flat use factors when the member dimension parallel to wide faces of laminations is less than 12":

Flat Use Factors,  $C_{fu}$

Member dimension parallel to wide faces of laminations	$C_{fu}$
10-3/4" or 10-1/2"	1.01
8-3/4" or 8-1/2"	1.04
6-3/4"	1.07
5-1/8" or 5"	1.10
3-1/8" or 3"	1.16
2-1/2"	1.19

**Table 5D Reference Design Values for Structural Glued Laminated Hardwood Timber**

(Members stressed primarily in axial tension or compression)<sup>1,2</sup> (Tabulated design values are for normal load duration and dry service conditions. See NDS 5.3 for a comprehensive description of design value adjustment factors.)

**Use with Table 5D Adjustment Factors**

Combination Symbol	Species Group	Grade	All Loading		Axially Loaded		Bending about Y-Y Axis Loaded Parallel to Wide Faces of Laminations				Bending About X-X Axis Loaded Perpendicular to Wide Faces of Laminations							
			Modulus of Elasticity E (10 <sup>6</sup> psi)	Modulus of Elasticity for Beam and Column Stability E <sub>min</sub> (10 <sup>6</sup> psi)	Compression Perpendicular to Grain F <sub>cL</sub> (psi)	Tension Parallel to Grain F <sub>t</sub> (psi)	Compression Parallel to Grain F <sub>c</sub> (psi)	Bending		Shear Parallel to Grain		F <sub>vx</sub> (psi)	F <sub>bx</sub> (psi)	F <sub>vx</sub> (psi)				
								4 or More Laminations F <sub>bx</sub> (psi)	3 Laminations F <sub>by</sub> (psi)	2 Laminations F <sub>by</sub> (psi)	4 or More Laminations for members with multiple piece laminations <sup>(3)</sup> F <sub>vy</sub> (psi)				3 Laminations F <sub>vy</sub> (psi)	2 Laminations F <sub>vy</sub> (psi)	4 or More Laminations to 15 in. Deep <sup>(4)</sup> without Special Tension Lams F <sub>bx</sub> (psi)	2 Laminations to 15 in. Deep <sup>(4)</sup> without Special Tension Lams F <sub>bx</sub> (psi)
<b>Visually Graded Hardwoods</b>																		
H1	A	N3	1.3	0.67	835	425	900	900	1,250	1,100	875	90	175	165	150	925	1,200	200
H2	A	N2	1.5	0.78	835	875	1,300	1,700	1,550	1,300	1,300	90	175	165	150	1,200	1,500	200
H3	A	N1	1.7	0.88	835	1,000	1,450	2,000	1,800	1,550	1,550	90	175	165	150	1,600	1,800	200
H4	A	SS	1.7	0.88	835	1,150	1,600	2,000	1,850	1,600	1,600	90	175	165	150	1,700	2,000	200
H5	B	N3	1.2	0.82	590	350	800	1,050	900	750	750	80	160	150	135	750	1,000	180
H6	B	N2	1.3	0.67	590	750	1,150	1,450	1,300	1,050	1,050	80	160	150	135	1,000	1,200	180
H7	B	N1	1.5	0.78	590	850	1,300	1,650	1,500	1,300	1,300	80	160	150	135	1,350	1,600	180
H8	B	SS	1.5	0.78	590	950	1,450	1,700	1,550	1,350	1,350	80	160	150	135	1,400	1,700	180
H9	C	N3	1.0	0.52	405	300	625	900	800	625	625	70	135	130	115	675	900	155
H10	C	N2	1.2	0.82	405	625	900	1,200	1,100	925	925	70	135	130	115	875	1,100	155
H11	C	N1	1.3	0.67	405	725	1,000	1,400	1,300	1,100	1,100	70	135	130	115	1,150	1,400	155
H12	C	SS	1.3	0.67	405	825	1,100	1,450	1,350	1,150	1,150	70	135	130	115	1,200	1,500	155
H13	D	N3	0.9	0.47	285	250	575	775	675	550	550	55	110	105	95	575	775	125
H14	D	N2	1.1	0.57	285	550	825	1,050	950	800	800	55	110	105	95	750	925	125
H15	D	N1	1.2	0.82	285	625	925	1,200	1,100	950	950	55	110	105	95	1,000	1,150	125
H16	D	SS	1.2	0.62	285	700	1,050	1,250	1,150	1,000	1,000	55	110	105	95	1,050	1,300	125

only to be used with the 2005 NDS® and Wood Structural Design Data

**Table 5D Reference Design Values for Structural Glued Laminated Hardwood Timber**

(Members stressed primarily in axial tension or compression)<sup>1,2</sup> (Tabulated design values are for normal load duration and dry service conditions. See NDS 5.3 for a comprehensive description of design value adjustment factors.)

**Use with Table 5D Adjustment Factors**

Combination Symbol	Species Group	Grade	All Loading		Axially Loaded		Bending about Y-Y Axis Loaded Parallel to Wide Faces of Laminations				Bending About X-X Axis Loaded Perpendicular to Wide Faces of Laminations								
			Modulus of Elasticity E (10 <sup>6</sup> psi)	Modulus of Elasticity for Beam and Column Stability E <sub>min</sub> (10 <sup>6</sup> psi)	Compression Perpendicular to Grain F <sub>c,L</sub> (psi)	Tension Parallel to Grain F <sub>t</sub> (psi)	Compression Parallel to Grain F <sub>c</sub> (psi)	Bending		Shear Parallel to Grain		Bending		Shear Parallel to Grain					
								3 Lami-nations F <sub>by</sub> (psi)	2 Lami-nations F <sub>by</sub> (psi)	4 or More Lami-nations F <sub>vy</sub> (psi)	4 or More Lami-nations F <sub>vy</sub> (psi)	2 Lami-nations to 15 in. Deep without Special Tension Lams (6) F <sub>bx</sub> (psi)	4 or More Lami-nations with Special Tension Lams (6) F <sub>bx</sub> (psi)	2 or More Lami-nations F <sub>vx</sub> (psi)	2 or More Lami-nations F <sub>vx</sub> (psi)				
<b>E-Rated Hardwoods</b>																			
H17	A	1.5E3	1.4	0.73	1,015	1,000	1,500	1,350	1,850	1,750	1,550	90	175	165	150	1,200	1,450	200	200
H18	A	1.8E3	1.7	0.88	1,015	1,150	1,950	1,850	2,100	2,000	1,750	90	175	165	150	1,200	1,450	200	200
H19	A	1.8E6	1.7	0.88	1,015	1,450	2,000	1,900	2,300	2,200	1,950	90	175	165	150	1,650	2,000	200	200
H20	A	2.0E3	1.9	0.98	1,015	1,350	2,600	2,200	2,400	2,300	2,100	90	175	165	150	1,700	2,200	200	200
H21	A	2.0E6	1.9	0.98	1,015	1,700	2,300	2,300	2,400	2,400	2,300	90	175	165	150	2,100	2,600	200	200
H22	B	1.5E3	1.4	0.73	770	1,000	1,500	1,350	1,850	1,750	1,550	80	160	150	135	1,200	1,450	180	180
H23	B	1.8E3	1.7	0.88	770	1,150	1,950	1,850	2,100	2,000	1,750	80	160	150	135	1,200	1,450	180	180
H24	B	1.8E6	1.7	0.88	770	1,450	2,000	1,900	2,300	2,200	1,950	80	160	150	135	1,650	2,000	180	180
H25	B	2.0E3	1.9	0.98	770	1,350	2,300	2,200	2,400	2,300	2,100	80	160	150	135	1,700	2,200	180	180
H26	B	2.0E6	1.9	0.98	770	1,700	2,400	2,300	2,400	2,400	2,300	80	160	150	135	2,100	2,600	180	180
H27	C	1.5E3	1.4	0.73	590	1,000	1,500	1,350	1,850	1,750	1,550	70	135	130	115	1,200	1,450	155	155
H28	C	1.8E3	1.7	0.88	590	1,150	1,950	1,850	2,100	2,000	1,750	70	135	130	115	1,450	1,850	155	155
H29	C	1.8E6	1.7	0.88	590	1,450	2,000	1,900	2,300	2,200	1,950	70	135	130	115	1,650	2,000	155	155
H30	C	2.0E3	1.9	0.98	590	1,350	2,300	2,200	2,400	2,300	2,100	70	135	130	115	1,700	2,200	155	155
H31	C	2.0E6	1.9	0.98	590	1,700	2,400	2,300	2,400	2,400	2,300	70	135	130	115	2,100	2,600	155	155
H32	D	1.5E3	1.4	0.73	440	1,000	1,500	1,350	1,850	1,750	1,550	55	110	105	95	1,200	1,450	125	125
H33	D	1.5E6	1.4	0.73	440	1,250	1,900	1,400	2,000	1,900	1,700	55	110	105	95	1,200	1,450	125	125
H34	D	1.8E3	1.7	0.88	440	1,150	1,950	1,850	2,100	2,000	1,750	55	110	105	95	1,450	1,850	125	125
H35	D	1.8E6	1.7	0.88	440	1,450	2,000	1,900	2,300	2,200	1,950	55	110	105	95	1,650	2,000	125	125
H36	D	2.0E3	1.9	0.98	440	1,350	2,300	2,200	2,400	2,300	2,100	55	110	105	95	1,700	2,200	125	125
H37	D	2.0E6	1.9	0.98	440	1,700	2,400	2,300	2,400	2,400	2,300	55	110	105	95	2,100	2,600	125	125

1. Design values in this table are for combinations conforming to AITC 119-96 (Standard Specifications for Structural Glued Laminated Timber of Hardwood Species), by American Institute of Timber Construction, and manufactured in accordance with American National Standard ANSI/AITC A190.1-2002 (Structural Glued Laminated Timber).

2. The combinations in this table are intended primarily for members loaded axially or in bending with the loads acting parallel to the wide faces of the laminations (bending about Y-Y axis). Design values for bending due to loading applied perpendicular to the wide faces of the laminations (bending about X-X axis) are also included; however, the combinations in Table 5C are preferred for this condition of loading.

3. Values apply to members manufactured using multiple piece laminations with unbonded edge joints. For members with 5, 7, or 9 laminations, value shall be multiplied by 0.8.

4. For members greater than 15" deep, values shall be reduced by multiplying by a factor of 0.88.

5. These design values require the use of special tension laminations. If these design values are used, the designer shall specify the required design value as well as the combination symbol.



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**2007 ERRATA/ADDENDUM  
to the**

**2005 Edition of**

***the National Design Specification® (NDS®) for Wood Construction Supplement: Design Values for Wood Construction***

(printed versions dated 04-05 2M, 09-05 2M, and 08-06 5M; web version 07-07)

**Page Revision**

4 In Table 2.1, revise the following:

Species or Species Combination	Species That May Be Included in Combination	Grading Rules Agencies	Design Values Provided in Tables
Coast Sitka Spruce	Coast Sitka Spruce	NLGA	4A, 4D, 4E
<u>Yellow Cedar</u>	<u>Yellow Cedar</u>	<u>NLGA</u>	<u>4A</u>

32 In Table 4A, add the following design values for Coast Sitka Spruce

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							
		Bending F <sub>b</sub>	Tension parallel to grain F <sub>t</sub>	Shear parallel to grain F <sub>v</sub>	Compression perpendicular to grain F <sub>c⊥</sub>	Compression parallel to grain F <sub>c</sub>	Modulus of Elasticity		Grading Rules Agency
							E	E <sub>min</sub>	
<b>Coast Sitka Spruce<sup>4</sup></b>									
Select Structural No. 1 / No. 2	2" & wider	1300	950	125	455	1200	1,700,000	620,000	NLGA
No. 3		525	325	125	455	625	1,400,000	510,000	
Stud	2" & wider	725	450	125	455	675	1,400,000	510,000	
Construction Standard	2"-4" wide	1050	650	125	455	1300	1,400,000	510,000	
Utility		600	350	125	455	1100	1,300,000	470,000	
		275	175	125	455	725	1,200,000	440,000	

34 In Table 4A, revise the following design values for Northern Species

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							
		Bending F <sub>b</sub>	Tension parallel to grain F <sub>t</sub>	Shear parallel to grain F <sub>v</sub>	Compression perpendicular to grain F <sub>c⊥</sub>	Compression parallel to grain F <sub>c</sub>	Modulus of Elasticity		Grading Rules Agency
							E	E <sub>min</sub>	
<b>Northern Species</b>									
Select Structural No. 1 / No. 2	2" & wider	<del>1,000</del> 975	<del>450</del> 425	110	350	1,100	1,100,000	400,000	NLGA
No. 3		<del>600</del> 625	275	110	350	850	1,100,000	400,000	
Stud	2" & wider	350	150	110	350	500	1,000,000	370,000	
Construction Standard	2"-4" wide	475	225	110	350	550	1,000,000	370,000	
Utility		700	<del>300</del> 325	110	350	1,050	1,000,000	370,000	
		400	175	110	350	875	900,000	330,000	
		175	75	110	350	575	900,000	330,000	

**Page Revision**

36 In Table 4A, add the following design values for Yellow Cedar

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending F <sub>b</sub>	Tension parallel to grain F <sub>t</sub>	Shear parallel to grain F <sub>v</sub>	Compression perpendicular to grain F <sub>cL</sub>	Compression parallel to grain F <sub>c</sub>	Modulus of Elasticity		
							E	E <sub>min</sub>	
<b>Yellow Cedar<sup>4</sup></b>									
Select Structural		1200	725	175	540	1200	1,600,000	580,000	NLGA
No. 1 / No. 2	2" & wider	800	475	175	540	1000	1,400,000	510,000	
No. 3		475	275	175	540	575	1,200,000	440,000	
Stud	2" & wider	625	375	175	540	650	1,200,000	440,000	
Construction		925	550	175	540	1200	1,300,000	470,000	
Standard	2"-4" wide	525	300	175	540	1050	1,200,000	440,000	
Utility		250	150	175	540	675	1,100,000	400,000	

36 In Table 4A, add the following footnote:

**4. SPECIFIC GRAVITY, G.** Specific gravity values are provided below for visually graded dimension lumber. Note that the value for Coast Sitka Spruce is applicable only for visually graded dimension lumber (2" – 4" thick). See NDS Table 11.3.2A for the specific gravity value applicable to Coast Sitka Spruce used as visually graded timber (5"x5" and larger) and visually graded decking.

Species	Specific Gravity, G	Grading Rules Agency
Coast Sitka Spruce	0.43	NLGA
Yellow Cedar	0.46	NLGA

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