

# SOUTHERN PINE REFERENCE DESIGN VALUES

Based on SPIB Grading Rules and AWC National Design Specification®  
Values in pounds per square inch (psi)

**Table 1 Dimension Lumber – 2" to 4" thick, 2" and wider**

Effective June 1, 2013

Based on Normal Load Duration and Dry Service (MC ≤ 19%) — See Tables A-1 thru A-4 for Adjustment Factors

Size	Grade	Bending	Tension	Shear	Compression	Compression	Modulus of Elasticity	
		F <sub>b</sub>	Parallel to Grain F <sub>t</sub>	Parallel to Grain F <sub>v</sub>	Perpendicular to Grain F <sub>c⊥</sub>	Parallel to Grain F <sub>c</sub>	E	E <sub>min</sub>
<b>2" to 4" thick,</b> <b>2" to 4" wide</b>	Dense Select Structural . . . . .	2700	1900	175	660	2050	1,900,000	690,000
	Select Structural . . . . .	2350	1650	175	565	1900	1,800,000	660,000
	Non-Dense Select Structural . . .	2050	1450	175	480	1800	1,600,000	580,000
	No.1 Dense . . . . .	1650	1100	175	660	1750	1,800,000	660,000
	No.1 . . . . .	1500	1000	175	565	1650	1,600,000	580,000
	No.1 Non-Dense . . . . .	1300	875	175	480	1550	1,400,000	510,000
	No.2 Dense . . . . .	1200	750	175	660	1500	1,600,000	580,000
	No.2 . . . . .	1100	675	175	565	1450	1,400,000	510,000
	No.2 Non-Dense . . . . .	1050	600	175	480	1450	1,300,000	470,000
	No.3 and Stud . . . . .	650	400	175	565	850	1,300,000	470,000
<b>Includes:</b> <b>2x2</b> <b>2x3</b> <b>2x4</b> <b>3x3</b> <b>3x4</b> <b>4x4</b>	Construction . . . . .	875	500	175	565	1600	1,400,000	510,000
	Standard . . . . .	475	275	175	565	1300	1,200,000	440,000
	Utility <sup>1</sup> . . . . .	225	125	175	565	850	1,200,000	440,000
	Dense Select Structural . . . . .	2400	1650	175	660	1900	1,900,000	690,000
	Select Structural . . . . .	2100	1450	175	565	1800	1,800,000	660,000
	Non-Dense Select Structural . . .	1850	1300	175	480	1700	1,600,000	580,000
	No.1 Dense . . . . .	1500	1000	175	660	1650	1,800,000	660,000
	No.1 . . . . .	1350	875	175	565	1550	1,600,000	580,000
	No.1 Non-Dense . . . . .	1200	775	175	480	1450	1,400,000	510,000
	No.2 Dense . . . . .	1050	650	175	660	1450	1,600,000	580,000
<b>Includes:</b> <b>2x5</b> <b>2x6</b> <b>3x5</b> <b>3x6</b> <b>4x5</b> <b>4x6</b>	No.2 . . . . .	1000	600	175	565	1400	1,400,000	510,000
	No.2 Non-Dense . . . . .	950	525	175	480	1350	1,300,000	470,000
	No.3 and Stud . . . . .	575	350	175	565	800	1,300,000	470,000
	Dense Select Structural . . . . .	2200	1550	175	660	1850	1,900,000	690,000
	Select Structural . . . . .	1950	1350	175	565	1700	1,800,000	660,000
	Non-Dense Select Structural . . .	1700	1200	175	480	1650	1,600,000	580,000
	No.1 Dense . . . . .	1350	900	175	660	1600	1,800,000	660,000
	No.1 . . . . .	1250	800	175	565	1500	1,600,000	580,000
	No.1 Non-Dense . . . . .	1100	700	175	480	1400	1,400,000	510,000
	No.2 Dense . . . . .	975	600	175	660	1400	1,600,000	580,000
<b>Includes:</b> <b>2x8</b> <b>3x8</b> <b>4x8<sup>2</sup></b>	No.2 . . . . .	925	550	175	565	1350	1,400,000	510,000
	No.2 Non-Dense . . . . .	875	500	175	480	1300	1,300,000	470,000
	No.3 and Stud . . . . .	525	325	175	565	775	1,300,000	470,000
	Dense Select Structural . . . . .	1950	1300	175	660	1800	1,900,000	690,000
	Select Structural . . . . .	1700	1150	175	565	1650	1,800,000	660,000
	Non-Dense Select Structural . . .	1500	1050	175	480	1600	1,600,000	580,000
	No.1 Dense . . . . .	1200	800	175	660	1550	1,800,000	660,000
	No.1 . . . . .	1050	700	175	565	1450	1,600,000	580,000
	No.1 Non-Dense . . . . .	950	625	175	480	1400	1,400,000	510,000
	No.2 Dense . . . . .	850	525	175	660	1350	1,600,000	580,000
<b>Includes:</b> <b>2x10</b> <b>3x10</b> <b>4x10<sup>2</sup></b>	No.2 . . . . .	800	475	175	565	1300	1,400,000	510,000
	No.2 Non-Dense . . . . .	750	425	175	480	1250	1,300,000	470,000
	No.3 and Stud . . . . .	475	275	175	565	750	1,300,000	470,000
	Dense Select Structural . . . . .	1800	1250	175	660	1750	1,900,000	690,000
	Select Structural . . . . .	1600	1100	175	565	1650	1,800,000	660,000
	Non-Dense Select Structural . . .	1400	975	175	480	1550	1,600,000	580,000
	No.1 Dense . . . . .	1100	750	175	660	1500	1,800,000	660,000
	No.1 . . . . .	1000	650	175	565	1400	1,600,000	580,000
	No.1 Non-Dense . . . . .	900	575	175	480	1350	1,400,000	510,000
	No.2 Dense . . . . .	800	500	175	660	1300	1,600,000	580,000
<b>Includes:</b> <b>2x12</b> <b>3x12</b> <b>4x12<sup>2</sup></b>	No.2 . . . . .	750	450	175	565	1250	1,400,000	510,000
	No.2 Non-Dense . . . . .	700	400	175	480	1250	1,300,000	470,000
	No.3 and Stud . . . . .	450	250	175	565	725	1,300,000	470,000

(1) For Utility, design values apply to 4"-wide lumber only. (2) For lumber 4" thick and 8" or wider, multiply the F<sub>b</sub> value by C<sub>F</sub> = 1.1. (3) For lumber wider than 12", multiply these 12"-width design values for F<sub>b</sub>, F<sub>t</sub> and F<sub>c</sub> by C<sub>F</sub> = .90, and use these 12"-width design values for the other properties.

The Southern Forest Products Association (SPPA) does not test lumber or establish design values. Neither SPPA, nor its members, warrant that the design values are correct, and disclaim responsibility for injury or damage resulting from the use of such design values.

Effective June 1, 2013

## Table 2 Mechanically Graded Lumber – 4" and less in thickness, 2" and wider

Based on Normal Load Duration and Dry Service (MC ≤ 19%) — See Tables A-1 thru A-4 for Adjustment Factors

Grade	Bending F <sub>b</sub>	Tension Parallel to Grain F <sub>t</sub>	Shear Parallel to Grain F <sub>v</sub> <sup>1</sup>	Compression Perpendicular to Grain F <sub>cL</sub> <sup>1</sup>	Compression Parallel to Grain F <sub>c</sub>	E	Modulus of Elasticity E <sub>min</sub>
<b>Machine Stress Rated (MSR) Lumber</b>							
750f – 1.4E	750	425	175	565	925	1,400,000	710,000
850f – 1.4E	850	475	175	565	975	1,400,000	710,000
975f – 1.6E	975	550	175	565	1450	1,600,000	810,000
1050f – 1.2E	1050	450	175	565	1225	1,200,000	610,000
1050f – 1.6E	1050	575	175	565	1500	1,600,000	810,000
1200f – 1.3E	1200	600	175	565	1400	1,300,000	660,000
1200f – 1.6E	1200	650	175	565	1550	1,600,000	810,000
1250f – 1.6E	1250	725	175	565	1600	1,600,000	810,000
1350f – 1.4E	1350	750	175	565	1600	1,400,000	710,000
1450f – 1.3E	1450	825	175	565	1600	1,300,000	660,000
1500f – 1.5E	1500	900	175	565	1650	1,500,000	760,000
1500f – 1.6E	1500	900	175	565	1650	1,600,000	810,000
1500f – 1.7E	1500	900	175	565	1650	1,700,000	860,000
1650f – 1.5E	1650	1020	175	565	1700	1,500,000	760,000
1650f – 1.7E	1650	1020	175	565	1750	1,700,000	860,000
1800f – 1.6E	1800	1175	175	565	1750	1,600,000	810,000
1850f – 1.7E	1850	1175	175	565	1850	1,700,000	860,000
1950f – 1.5E	1950	1375	175	565	1800	1,500,000	760,000
1950f – 1.7E	1950	1375	175	565	1800	1,700,000	860,000
2100f – 1.8E <sup>2</sup>	2100	1575	190	805	1875	1,800,000	910,000
2250f – 1.9E	2250	1750	190	805	1925	1,900,000	970,000
2400f – 2.0E	2400	1925	190	805	1975	2,000,000	1,020,000
2550f – 1.8E <sup>2</sup>	2550	1400	190	805	2000	1,800,000	910,000
2550f – 2.1E	2550	2050	190	805	2025	2,100,000	1,070,000
2700f – 2.2E	2700	2150	190	805	2100	2,200,000	1,120,000
2850f – 1.8E <sup>2</sup>	2850	1600	190	805	2100	1,800,000	910,000
2850f – 2.3E	2850	2300	190	805	2150	2,300,000	1,170,000
3000f – 2.4E	3000	2400	190	805	2200	2,400,000	1,220,000

(1) When a grade is qualified by test and quality controlled for specific gravity, the shear and compression perpendicular-to-grain design values may be higher.

(2) When not qualified by test and quality controlled for specific gravity, the grademark for mechanically graded lumber grades with a 1,800,000 psi modulus of elasticity design value shall include a specific gravity of .55, a shear value of 175 psi, and a compression perpendicular-to-grain value of 565 psi.

Design values for Southern Pine lumber are published by the Southern Pine Inspection Bureau (SPIB) after approval by the Board of Review of the American Lumber Standard Committee (ALSC). The Southern Forest Products Association (SFPA) does not test lumber or establish design values. Neither SFPA, nor its members, warrant that the design values are correct, and disclaim responsibility for injury or damage resulting from the use of such design values. The SPIB Standard Grading Rules for Southern Pine Lumber provide for numerous visual and mechanical lumber grades. However, not all of those possible grade/size combinations are produced or used in the marketplace. Check sources of supply as available grades and sizes are subject to change.

## Table 2 (continued) Mechanically Graded Lumber – 4" and less in thickness, 2" and wider

Based on Normal Load Duration and Dry Service ( $MC \leq 19\%$ ) — See Tables A-1 thru A-4 for Adjustment Factors

Grade	Bending $F_b$	Tension Parallel to Grain $F_t$	Shear Parallel to Grain $F_v^1$	Compression Perpendicular to Grain $F_{cL}^1$	Compression Parallel to Grain $F_c$	Modulus of Elasticity E	$E_{min}$
<b>Machine Evaluated Lumber (MEL)</b>							
M-32	750	425	175	565	925	1,400,000	650,000
M-33	850	475	175	565	975	1,400,000	650,000
M-5	900	500	175	565	1050	1,100,000	510,000
M-34	975	550	175	565	1450	1,600,000	750,000
M-35	1050	575	175	565	1500	1,600,000	750,000
M-6	1100	600	175	565	1300	1,000,000	470,000
M-7	1200	650	175	565	1400	1,100,000	510,000
M-36	1200	650	175	565	1550	1,600,000	750,000
M-37	1250	725	175	565	1600	1,600,000	750,000
M-8	1300	700	175	565	1500	1,300,000	610,000
M-10	1400	800	175	565	1600	1,200,000	560,000
M-9	1400	800	175	565	1600	1,400,000	650,000
M-38	1500	900	175	565	1650	1,600,000	750,000
M-11	1550	850	175	565	1675	1,500,000	700,000
M-29	1550	850	175	565	1650	1,700,000	790,000
M-12	1600	850	175	565	1675	1,600,000	750,000
M-13	1600	950	175	565	1675	1,400,000	650,000
M-39	1650	1020	175	565	1750	1,700,000	790,000
M-15	1800	1100	175	565	1750	1,500,000	700,000
M-16	1800	1300	175	565	1750	1,500,000	700,000
M-14	1800	1000	175	565	1750	1,700,000	790,000
M-40	1850	1175	175	565	1850	1,700,000	790,000
M-17 <sup>3</sup>	1950	1300	175	565	2050	1,700,000	790,000
M-19	2000	1300	175	565	1825	1,600,000	750,000
M-18 <sup>2</sup>	2000	1200	190	805	1825	1,800,000	840,000
M-20 <sup>3</sup>	2000	1600	190	805	2100	1,900,000	890,000
M-30	2050	1050	175	565	1850	1,700,000	790,000
M-28	2200	1600	175	565	1900	1,700,000	790,000
M-21	2300	1400	190	805	1950	1,900,000	890,000
M-22	2350	1500	175	565	1950	1,700,000	790,000
M-23 <sup>2</sup>	2400	1900	190	805	1975	1,800,000	840,000
M-41 <sup>2</sup>	2550	1400	190	805	2000	1,800,000	840,000
M-24	2700	1800	190	805	2100	1,900,000	890,000
M-25	2750	2000	190	805	2100	2,200,000	1,030,000
M-26	2800	1800	190	805	2150	2,000,000	930,000
M-42 <sup>2</sup>	2850	1600	190	805	2100	1,800,000	840,000
M-31	2850	1600	190	805	2150	1,900,000	890,000
M-27 <sup>3</sup>	3000	2000	190	805	2400	2,100,000	980,000

(1) When a grade is qualified by test and quality controlled for specific gravity, the shear and compression perpendicular-to-grain design values may be higher. (2) When not qualified by test and quality controlled for specific gravity, the grademark for mechanically graded lumber grades with a 1,800,000 psi modulus of elasticity design value shall include a specific gravity of .55, a shear value of 175 psi, and a compression perpendicular-to-grain value of 565 psi. (3) MEL grades requiring compression parallel-to-grain qualification and quality control.

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Reference design values are for normal load duration under the moisture service conditions specified. Because the strength of wood varies with conditions under which it is used, reference design values should only be applied in conjunction with appropriate design and service recommendations from the *National Design Specification® (NDS®) for Wood Construction* published by the American Wood Council. The latest connection design information is also provided in the *NDS*.

Reference design values ( $F_b$ ,  $F_t$ ,  $F_v$ ,  $F_{c\perp}$ ,  $F_c$ ,  $E$ ,  $E_{min}$ ) in Tables 1 thru 3 shall be multiplied by all applicable adjustment factors to determine adjusted design values ( $F_b'$ ,  $F_t'$ ,  $F_v'$ ,  $F_{c\perp}'$ ,  $F_c'$ ,  $E'$ ,  $E_{min}'$ ).

Table A-1 is excerpted from the *NDS* and summarizes the applicability of adjustment factors for solid-sawn lumber.

**Table A-1 Applicability of Adjustment Factors for Sawn Lumber**

Adjusted Design Value	Reference Design Value	ASD only		ASD and LRFD										LRFD only		
		Load Duration Factor	Wet Service Factor	Temperature Factor	Beam Stability Factor	Size Factor	Flat Use Factor	Inclining Factor	Repetitive Member Factor	Column Stability Factor	Buckling Stiffness Factor	Bearing Area Factor	Format Conversion Factor	Resistance Factor	Time Effect Factor	
$F_b' = F_b * C_D * C_M * C_t * C_L * C_F * C_{fu} * C_i * C_r *$																$2.54 * 0.85 * \lambda$
$F_t' = F_t * C_D * C_M * C_t * C_F * C_i *$																$2.70 * 0.80 * \lambda$
$F_v' = F_v * C_D * C_M * C_t * C_i *$																$2.88 * 0.75 * \lambda$
$F_c' = F_c * C_D * C_M * C_t * C_F * C_i * C_p *$																$2.40 * 0.90 * \lambda$
$F_{c\perp}' = F_{c\perp} * C_M * C_t * C_i * C_b *$																$1.67 * 0.90$
$E' = E * C_M * C_t * C_i *$																
$E_{min}' = E_{min} * C_M * C_t * C_i * C_T *$																$1.76 * 0.85$

ASD – Allowable Stress Design; LRFD – Load and Resistance Factor Design

Tables A-2 thru A-4 highlight the most common adjustment factors as they apply to Southern Pine. In addition, Table 1 and 3 footnotes provide information about the Size Factor,  $C_F$ . For complete information on adjustment factors, see the *NDS*.

**Table A-2 Wet Service Factor,  $C_M$**

For lumber 2" to 4" thick

Applies to all values

When dimension lumber is used under conditions where the moisture content of the wood in service will exceed 19% for an extended time period, reference design values shall be multiplied by the appropriate wet service factors to the right.

$F_b$	$F_t$	$F_v$	$F_{c\perp}$	$F_c$	$E$	$E_{min}$
0.85 <sup>1</sup>	1.0	0.97	0.67	0.8 <sup>2</sup>	0.9	0.9
(1) When $F_b \leq 1150$ psi, $C_M = 1.0$			(2) When $F_c \leq 750$ psi, $C_M = 1.0$			

**Table A-3 Load Duration Factor,  $C_D$**

For all solid wood products – Allowable Stress Design Only

Applies to  $F_b$ ,  $F_t$ ,  $F_v$ , and  $F_c$  values  
Does not apply to  $F_{c\perp}$ ,  $E$ , and  $E_{min}$  values

Wood has the property of carrying substantially greater maximum loads for short durations than for long durations of loading. Reference design values apply to normal load duration, meaning a load that fully stresses a member to its allowable design value by the application of the full design load for a cumulative duration of approximately ten years. When the cumulative duration of the full maximum load does not exceed the specified time period, all reference design values (except  $F_{c\perp}$ ,  $E$ , and  $E_{min}$ ) shall be multiplied by the appropriate load duration factor. Frequently used load duration factors are provided to the right.

Load Duration (Typical Design Loads)	$C_D$
Permanent (dead load)	0.9
Ten years (occupancy live load)	1.0
Two months (snow load)	1.15
Seven days (construction load)	1.25
Ten minutes (wind/earthquake load)	1.6
Impact <sup>1</sup> (impact load)	2.0

(1) Load duration factors greater than 1.6 shall not apply to structural members pressure treated with waterborne preservatives, or fire-retardant chemicals. The impact load duration factor shall not apply to connections.

**Table A-4 Flat Use Factor,  $C_{fu}$**

For lumber 2" to 4" thick

Applies to  $F_b$  values only

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

Width (depth)	Flat Use Factors, $C_{fu}$	
	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