REFERENCE DESIGN VALUES

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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 $(F_b)(C_F) \le 1{,}150$ psi, $C_M = 1.0$

** when $(F_c)(C_F) \le 750$ 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 permitted to 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

		F_b		F_t	F_c
		Thickness (breadth)			
Grades	Width (depth)	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 4A Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)[1,2,3]

(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)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
ALASKA CEDAR										
Select Structural	2" & wider	1,150	625	165	525	1,000	1,400,000	510,000	0.47	WCLIB
No. 1		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		
ALASKA HEMLOCK										
Select Structural	2" & wider	1,300	825	185	440	1,200	1,700,000	620,000	0.46	WWPA
No. 1		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		
ALASKA SPRUCE										
Select Structural	2" & wider	1,400	900	160	330	1,200	1,600,000	580,000	0.41	WWPA
No. 1		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		
ALASKA YELLOW CEDAR										
Select Structural	2" & wider	1,350	800	225	510	1,200	1,500,000	550,000	0.46	WCLIB WWPA
No. 1		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		
ASPEN										
Select Structural	2" & wider	875	500	120	265	725	1,100,000	400,000	0.39	NELMA WWPA
No. 1		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		
BALDCYPRESS										
Select Structural	2" & wider	1,200	650	160	615	1,200	1,400,000	510,000	0.47	SPIB
No. 1		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 (Cont.) Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)[1,2,3]

(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)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
BEECH-BIRCH-HICKORY										
Select Structural	2" & wider	1,450	850	195	715	1,200	1,700,000	620,000	0.71	NELMA
No. 1		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		
COAST SITKA SPRUCE										
Select Structural	2" & wider	1300	950	125	455	1200	1,700,000	620,000	0.43	NLGA
No. 1/ No. 2		925	550	125	455	1100	1,500,000	550,000		
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	2" - 4" wide	1050	650	125	455	1300	1,400,000	510,000		
Standard		600	350	125	455	1100	1,300,000	470,000		
Utility		275	175	125	455	725	1,200,000	440,000		
COTTONWOOD										
Select Structural	2" & wider	875	525	125	320	775	1,200,000	440,000	0.41	NELMA
No. 1		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		
DOUGLAS FIR-LARCH										
Select Structural	2" & wider	1,500	1,000	180	625	1,700	1,900,000	690,000	0.50	WCLIB WWPA
No. 1 & Btr		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		
DOUGLAS FIR-LARCH (NORTH)										
Select Structural	2" & wider	1,350	825	180	625	1,900	1,900,000	690,000	0.49	NLGA
No. 1 & Btr		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		
DOUGLAS FIR-SOUTH										
Select Structural	2" & wider	1,350	900	180	520	1,600	1,400,000	510,000	0.46	WWPA
No. 1		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		

Table 4A (Cont.) Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)[1,2,3]

(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)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
EASTERN HEMLOCK-BALSAM FIR										
Select Structural	2" & wider	1,250	575	140	335	1,200	1,200,000	440,000	0.36	NELMA
No. 1		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		
EASTERN HEMLOCK-TAMARACK										
Select Structural	2" & wider	1,250	575	170	555	1,200	1,200,000	440,000	0.41	NELMA
No. 1		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		
EASTERN SOFTWOODS										
Select Structural	2" & wider	1,250	575	140	335	1,200	1,200,000	440,000	0.36	NELMA
No. 1		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		
EASTERN WHITE PINE										
Select Structural	2" & wider	1,250	575	135	350	1,200	1,200,000	440,000	0.36	NELMA
No. 1		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		
HEM-FIR										
Select Structural	2" & wider	1,400	925	150	405	1,500	1,600,000	580,000	0.43	WCLIB WWPA
No. 1 & Btr		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		
HEM-FIR (NORTH)										
Select Structural	2" & wider	1,300	775	145	405	1,700	1,700,000	620,000	0.46	NLGA
No. 1 & Btr		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		

Table 4A (Cont.) Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)[1,2,3]

(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)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
MIXED MAPLE										
Select Structural	2" & wider	1,000	600	195	620	875	1,300,000	470,000	0.55	NELMA
No. 1		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		
MIXED OAK										
Select Structural	2" & wider	1,150	675	170	800	1,000	1,100,000	400,000	0.68	NELMA
No. 1		825	500	170	800	825	1,000,000	370,000		
No. 2		800	475	170	800	625	900,000	330,000		
No. 3		475	275	170	800	375	800,000	290,000		
Stud	2" & wider	625	375	170	800	400	800,000	290,000		
Construction	2" - 4" wide	925	550	170	800	850	900,000	330,000		
Standard		525	300	170	800	650	800,000	290,000		
Utility		250	150	170	800	425	800,000	290,000		
NORTHERN RED OAK										
Select Structural	2" & wider	1,400	800	220	885	1,150	1,400,000	510,000	0.68	NELMA
No. 1		1,000	575	220	885	925	1,400,000	510,000		
No. 2		975	575	220	885	725	1,300,000	470,000		
No. 3		550	325	220	885	425	1,200,000	440,000		
Stud	2" & wider	750	450	220	885	450	1,200,000	440,000		
Construction	2" - 4" wide	1,100	650	220	885	975	1,200,000	440,000		
Standard		625	350	220	885	750	1,100,000	400,000		
Utility		300	175	220	885	500	1,000,000	370,000		
NORTHERN SPECIES										
Select Structural	2" & wider	975	425	110	350	1,100	1,100,000	400,000	0.35	NLGA
No. 1/ No. 2		625	275	110	350	850	1,100,000	400,000		
No. 3		350	150	110	350	500	1,000,000	370,000		
Stud	2" & wider	475	225	110	350	550	1,000,000	370,000		
Construction	2" - 4" wide	700	325	110	350	1,050	1,000,000	370,000		
Standard		400	175	110	350	875	900,000	330,000		
Utility		175	75	110	350	575	900,000	330,000		
NORTHERN WHITE CEDAR										
Select Structural	2" & wider	775	450	120	370	750	800,000	290,000	0.31	NELMA
No. 1		575	325	120	370	600	700,000	260,000		
No. 2		550	325	120	370	475	700,000	260,000		
No. 3		325	175	120	370	275	600,000	220,000		
Stud	2" & wider	425	250	120	370	300	600,000	220,000		
Construction	2" - 4" wide	625	375	120	370	625	700,000	260,000		
Standard		350	200	120	370	475	600,000	220,000		
Utility		175	100	120	370	325	600,000	220,000		
NORWAY SPRUCE (NORTH)										
Select Structural	2" & wider	950	600	190	410	1,100	1,500,000	550,000	0.40	NLGA
No. 1/ No. 2		650	425	190	410	900	1,300,000	470,000		
No. 3		375	250	190	410	525	1,200,000	440,000		
Stud	2" & wider	500	325	190	410	575	1,200,000	440,000		
Construction	2" - 4" wide	725	475	190	410	1,100	1,200,000	440,000		
Standard		400	275	190	410	925	1,100,000	400,000		
Utility		200	125	190	410	600	1,100,000	400,000		

Table 4A (Cont.) Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)[1,2,3]

(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)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
RED MAPLE										
Select Structural	2" & wider	1,300	750	210	615	1,100	1,700,000	620,000	0.58	NELMA
No. 1		925	550	210	615	900	1,600,000	580,000		
No. 2		900	525	210	615	700	1,500,000	550,000		
No. 3		525	300	210	615	400	1,300,000	470,000		
Stud	2" & wider	700	425	210	615	450	1,300,000	470,000		
Construction	2" - 4" wide	1,050	600	210	615	925	1,400,000	510,000		
Standard		575	325	210	615	725	1,300,000	470,000		
Utility		275	150	210	615	475	1,200,000	440,000		
RED OAK										
Select Structural	2" & wider	1,150	675	170	820	1,000	1,400,000	510,000	0.67	NELMA
No. 1		825	500	170	820	825	1,300,000	470,000		
No. 2		800	475	170	820	625	1,200,000	440,000		
No. 3		475	275	170	820	375	1,100,000	400,000		
Stud	2" & wider	625	375	170	820	400	1,100,000	400,000		
Construction	2" - 4" wide	925	550	170	820	850	1,200,000	440,000		
Standard		525	300	170	820	650	1,100,000	400,000		
Utility		250	150	170	820	425	1,000,000	370,000		
REDWOOD										
Select Structural	2" & wider	1,100	625	160	425	1,100	1,100,000	400,000	0.37	RIS
No. 1		775	450	160	425	900	1,100,000	400,000		
No. 2		725	425	160	425	700	1,000,000	370,000		
No. 3		425	250	160	425	400	900,000	330,000		
Stud	2" & wider	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		
SPRUCE-PINE-FIR										
Select Structural	2" & wider	1,250	700	135	425	1,400	1,500,000	550,000	0.42	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	2" & wider	675	350	135	425	725	1,200,000	440,000		
Construction	2" - 4" wide	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		
SPRUCE-PINE-FIR (SOUTH)										
Select Structural	2" & wider	1,300	575	135	335	1,200	1,300,000	470,000	0.36	NELMA 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	2" & wider	600	275	135	335	625	1,000,000	370,000		
Construction	2" - 4" wide	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		
WESTERN CEDARS										
Select Structural	2" & wider	1,000	600	155	425	1,000	1,100,000	400,000	0.36	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	2" & wider	550	325	155	425	400	900,000	330,000		
Construction	2" - 4" wide	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		

Table 4A (Cont.) Reference Design Values for Visually Graded Dimension Lumber (2" - 4" thick)[1,2,3]

(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)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
WESTERN JUNIPER										
Select Structural	2" & wider	925	525	125	770	225	600,000	220,000	0.42	WCLIB
No. 1		800	425	125	770	200	600,000	220,000		
No. 2		650	350	125	770	175	500,000	180,000		
No. 3		375	200	125	770	100	500,000	180,000		
Stud	2" & wider	500	275	125	770	100	500,000	180,000		
Construction	2" - 4" wide	750	400	125	770	200	500,000	180,000		
Standard		425	225	125	770	175	500,000	180,000		
Utility		200	100	125	770	100	400,000	150,000		
WESTERN WOODS										
Select Structural	2" & wider	900	400	135	335	1,050	1,200,000	440,000	0.36	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	2" & wider	525	225	135	335	575	900,000	330,000		
Construction	2" - 4" wide	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		
WHITE OAK										
Select Structural	2" & wider	1,200	700	220	800	1,100	1,100,000	400,000	0.73	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	2" & wider	650	375	220	800	450	800,000	290,000		
Construction	2" - 4" wide	950	550	220	800	925	900,000	330,000		
Standard		525	325	220	800	725	800,000	290,000		
Utility		250	150	220	800	475	800,000	290,000		
YELLOW CEDAR										
Select Structural	2" & wider	1200	725	175	540	1200	1,600,000	580,000	0.46	NLGA
No. 1/ No. 2		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	2" - 4" wide	925	550	175	540	1200	1,300,000	470,000		
Standard		525	300	175	540	1050	1,200,000	440,000		
Utility		250	150	175	540	675	1,100,000	400,000		
YELLOW POPLAR										
Select Structural	2" & wider	1,000	575	145	420	900	1,500,000	550,000	0.43	NELMA
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	2" & wider	550	325	145	420	350	1,200,000	440,000		
Construction	2" - 4" wide	800	475	145	420	750	1,300,000	470,000		
Standard		450	250	145	420	575	1,100,000	400,000		
Utility		200	125	145	420	375	1,100,000	400,000		

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. **STRESS-RATED BOARDS.** Stress-rated boards of nominal 1", 1-¼" and 1-½" 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, and Utility 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.
3. 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.
4. Specific gravity, G, based on weight and volume when oven-dry.

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 permitted to 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 $(F_b)(C_F) \le 1{,}150$ psi, $C_M = 1.0$

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

Table 4B Reference Design Values for Visually Graded Southern Pine Dimension Lumber (2" - 4" thick)[1,2,3,4,5]

(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)							Specific Gravity[6]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
SOUTHERN PINE										
Dense Select Structural	2" - 4" wide	2,700	1,900	175	660	2,050	1,900,000	690,000	0.55	SPIB
Select Structural		2,350	1,650	175	565	1,900	1,800,000	660,000		
Non-Dense Select Structural		2,050	1,450	175	480	1,800	1,600,000	580,000		
No.1 Dense		1,650	1,100	175	660	1,750	1,800,000	660,000		
No.1		1,500	1,000	175	565	1,650	1,600,000	580,000		
No.1 Non-Dense		1,300	875	175	480	1,550	1,400,000	510,000		
No.2 Dense		1,200	750	175	660	1,500	1,600,000	580,000		
No.2		1,100	675	175	565	1,450	1,400,000	510,000		
No.2 Non-Dense		1,050	600	175	480	1,450	1,300,000	470,000		
No.3 and Stud		650	400	175	565	850	1,300,000	470,000		
Construction	4" wide	875	500	175	565	1,600	1,400,000	510,000	0.55	
Standard		475	275	175	565	1,300	1,200,000	440,000		
Utility		225	125	175	565	850	1,200,000	440,000		
Dense Select Structural	5" - 6" wide	2,400	1,650	175	660	1,900	1,900,000	690,000	0.55	
Select Structural		2,100	1,450	175	565	1,800	1,800,000	660,000		
Non-Dense Select Structural		1,850	1,300	175	480	1,700	1,600,000	580,000		
No.1 Dense		1,500	1,000	175	660	1,650	1,800,000	660,000		
No.1		1,350	875	175	565	1,550	1,600,000	580,000		
No.1 Non-Dense		1,200	775	175	480	1,450	1,400,000	510,000		
No.2 Dense		1,050	650	175	660	1,450	1,600,000	580,000		
No.2		1,000	600	175	565	1,400	1,400,000	510,000		
No.2 Non-Dense		950	525	175	480	1,350	1,300,000	470,000		
No.3 and Stud		575	350	175	565	800	1,300,000	470,000		
Dense Select Structural	8" wide	2,200	1,550	175	660	1,850	1,900,000	690,000	0.55	
Select Structural		1,950	1,350	175	565	1,700	1,800,000	660,000		
Non-Dense Select Structural		1,700	1,200	175	480	1,650	1,600,000	580,000		
No.1 Dense		1,350	900	175	660	1,600	1,800,000	660,000		
No.1		1,250	800	175	565	1,500	1,600,000	580,000		
No.1 Non-Dense		1,100	700	175	480	1,400	1,400,000	510,000		
No.2 Dense		975	600	175	660	1,400	1,600,000	580,000		
No.2		925	550	175	565	1,350	1,400,000	510,000		
No.2 Non-Dense		875	500	175	480	1,300	1,300,000	470,000		
No.3 and Stud		525	325	175	565	775	1,300,000	470,000		
Dense Select Structural	10" wide	1,950	1,300	175	660	1,800	1,900,000	690,000	0.55	
Select Structural		1,700	1,150	175	565	1,650	1,800,000	660,000		
Non-Dense Select Structural		1,500	1,050	175	480	1,600	1,600,000	580,000		
No.1 Dense		1,200	800	175	660	1,550	1,800,000	660,000		
No.1		1,050	700	175	565	1,450	1,600,000	580,000		
No.1 Non-Dense		950	625	175	480	1,400	1,400,000	510,000		
No.2 Dense		850	525	175	660	1,350	1,600,000	580,000		
No.2		800	475	175	565	1,300	1,400,000	510,000		
No.2 Non-Dense		750	425	175	480	1,250	1,300,000	470,000		
No.3 and Stud		475	275	175	565	750	1,300,000	470,000		
Dense Select Structural	12" wide	1,800	1,250	175	660	1,750	1,900,000	690,000	0.55	
Select Structural		1,600	1,100	175	565	1,650	1,800,000	660,000		
Non-Dense Select Structural		1,400	975	175	480	1,550	1,600,000	580,000		
No.1 Dense		1,100	750	175	660	1,500	1,800,000	660,000		
No.1		1,000	650	175	565	1,400	1,600,000	580,000		
No.1 Non-Dense		900	575	175	480	1,350	1,400,000	510,000		
No.2 Dense		800	500	175	660	1,300	1,600,000	580,000		
No.2		750	450	175	565	1,250	1,400,000	510,000		
No.2 Non-Dense		700	400	175	480	1,250	1,300,000	470,000		
No.3 and Stud		450	250	175	565	725	1,300,000	470,000		

Table 4B (Cont.) Reference Design Values for Visually Graded Southern Pine Dimension Lumber (2" - 4" thick)[1,2,3,4,5]

(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)							Specific Gravity[6]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
SOUTHERN PINE		(Surfaced Dry - Used in dry service condtions - 19% or less moisture content)								
Dense Structural 86	2" & wider	2,600	1,750	175	660	2,000	1,800,000	660,000	0.55	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		
SOUTHERN PINE		(Surfaced Green - Used in any service condtion)								
Dense Structural 86	2-1/2" & wider	2,100	1,400	165	440	1,300	1,600,000	580,000	0.55	SPIB
Dense Structural 72		1,750	1,200	165	440	1,100	1,600,000	580,000		
Dense Structural 65	2-1/2"-4" thick	1,600	1,050	165	440	1,000	1,600,000	580,000		
MIXED SOUTHERN PINE										
Select Structural	2" - 4" wide	2,050	1,200	175	565	1,800	1,600,000	580,000	0.51	SPIB
No.1		1,450	875	175	565	1,650	1,500,000	550,000		
No.2		1,100	675	175	565	1,450	1,400,000	510,000		
No.3 and Stud		650	400	175	565	850	1,200,000	440,000		
Construction	4" wide	875	500	175	565	1,600	1,300,000	470,000	0.51	
Standard		475	275	175	565	1,300	1,200,000	440,000		
Utility		225	125	175	565	850	1,100,000	400,000		
Select Structural	5" - 6" wide	1,850	1,100	175	565	1,700	1,600,000	580,000	0.51	
No.1		1,300	750	175	565	1,550	1,500,000	550,000		
No.2		1,000	600	175	565	1,400	1,400,000	510,000		
No.3 and Stud		575	350	175	565	800	1,200,000	440,000		
Select Structural	8" wide	1,750	1,000	175	565	1,600	1,600,000	580,000	0.51	
No.1		1,200	700	175	565	1,450	1,500,000	550,000		
No.2		925	550	175	565	1,350	1,400,000	510,000		
No.3 and Stud		525	325	175	565	775	1,200,000	440,000		
Select Structural	10" wide	1,500	875	175	565	1,600	1,600,000	580,000	0.51	
No.1		1,050	600	175	565	1,450	1,500,000	550,000		
No.2		800	475	175	565	1,300	1,400,000	510,000		
No.3 and Stud		475	275	175	565	750	1,200,000	440,000		
Select Structural	12" wide	1,400	825	175	565	1,550	1,600,000	580,000	0.51	
No.1		975	575	175	565	1,400	1,500,000	550,000		
No.2		750	450	175	565	1,250	1,400,000	510,000		
No.3 and Stud		450	250	175	565	725	1,200,000	440,000		

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. **STRESS-RATED BOARDS.** Information for various grades of Southern Pine stress-rated boards of nominal 1", 1-¼", and 1-½" thickness, 2" and wider is available from the Southern Pine Inspection Bureau (SPIB) in the *Standard Grading Rules for Southern Pine Lumber*.
3. **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; 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

	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}
Conversion Factor	0.78	0.78	0.98	0.73	0.78	0.82

4. **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.
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.
6. Specific gravity, G, based on weight and volume when oven-dry.

Table 4C Adjustment Factors

Flat Use Factor, C_{fu}

Bending design values 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 be permitted to 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 $F_b \le 1{,}150$ psi, $C_M = 1.0$

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

Table 4C Reference Design Values for Mechanically Graded Dimension Lumber[1,2,3]

(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

Commercial grade	Size classification	Design values in pounds per square inch (psi)					Grading Rules Agency
		Bending F_b	Tension parallel to grain F_t	Compression parallel to grain F_c	Modulus of Elasticity E	Modulus of Elasticity E_{min}	
MACHINE STRESS RATED (MSR) LUMBER							
750f-1.4E		750	425	925	1,400,000	710,000	SPIB
850f-1.4E		850	475	975	1,400,000	710,000	SPIB
900f-1.0E		900	350	1,050	1,000,000	510,000	WCLIB, WWPA, NELMA
975f-1.6E		975	550	1,450	1,600,000	810,000	SPIB
1050f-1.2E		1,050	450	1,225	1,200,000	610,000	SPIB
1050f-1.6E		1,050	575	1,500	1,600,000	810,000	SPIB
1200f-1.2E		1,200	600	1,400	1,200,000	610,000	NLGA, WCLIB, WWPA, NELMA
1200f-1.3E		1,200	600	1,400	1,300,000	660,000	SPIB
1200f-1.6E		1,200	650	1,550	1,600,000	810,000	SPIB
1250f-1.4E		1,250	800	1,475	1,400,000	710,000	WCLIB
1250f-1.6E		1,250	725	1,600	1,600,000	810,000	SPIB
1350f-1.3E		1,350	750	1,600	1,300,000	660,000	NLGA, WCLIB, WWPA, NELMA
1350f-1.4E		1,350	750	1,600	1,400,000	710,000	SPIB
1400f-1.2E		1,400	800	1,600	1,200,000	610,000	NLGA
1450f-1.3E		1,450	800	1,625	1,300,000	660,000	NLGA, WCLIB, WWPA, NELMA
1450f-1.3E		1,450	825	1,600	1,300,000	660,000	SPIB
1450f-1.5E		1,450	875	1,625	1,500,000	760,000	WCLIB
1500f-1.4E		1,500	900	1,650	1,400,000	710,000	NLGA, WCLIB, WWPA, NELMA
1500f-1.5E		1,500	900	1,650	1,500,000	760,000	SPIB
1500f-1.6E		1,500	900	1,650	1,600,000	810,000	SPIB
1500f-1.7E		1,500	900	1,650	1,700,000	860,000	SPIB
1600f-1.4E	2" and less in thickness	1,600	950	1,675	1,400,000	710,000	NLGA
1650f-1.3E		1,650	1,020	1,700	1,300,000	660,000	NLGA
1650f-1.5E		1,650	1,020	1,700	1,500,000	760,000	NLGA, SPIB, WCLIB, WWPA, NELMA
1650f-1.6E	2" and wider	1,650	1,175	1,700	1,600,000	810,000	WCLIB
1650f-1.7E		1,650	1,020	1,750	1,700,000	860,000	SPIB
1700f-1.6E		1700	1,175	1,725	1,600,000	810,000	WCLIB
1800f-1.5E		1,800	1,300	1,750	1,500,000	760,000	NLGA
1800f-1.6E		1,800	1,175	1,750	1,600,000	810,000	NLGA, SPIB, WCLIB, WWPA, NELMA
1800f-1.8E		1,800	1,200	1,750	1,800,000	910,000	WCLIB
1800f-2.0E		1,800	1,175	1,750	2,000,000	1,020,000	WCLIB
1850f-1.7E		1,850	1,175	1,850	1,700,000	860,000	SPIB
1950f-1.5E		1,950	1,375	1,800	1,500,000	760,000	SPIB
1950f-1.7E		1,950	1,375	1,800	1,700,000	860,000	NLGA, SPIB, WCLIB, WWPA, NELMA
2000f-1.6E		2,000	1,300	1,825	1,600,000	810,000	NLGA
2100f-1.8E		2,100	1,575	1,875	1,800,000	910,000	NLGA, SPIB, WCLIB, WWPA, NELMA
2250f-1.7E		2,250	1,750	1,925	1,700,000	860,000	NLGA
2250f-1.8E		2,250	1,750	1,925	1,800,000	910,000	NLGA, WCLIB
2250f-1.9E		2,250	1,750	1,925	1,900,000	970,000	NLGA, SPIB, WCLIB, WWPA, NELMA
2400f-1.8E		2,400	1,925	1,975	1,800,000	910,000	NLGA
2400f-2.0E		2,400	1,925	1,975	2,000,000	1,020,000	NLGA, SPIB, WCLIB, WWPA, NELMA
2500f-2.2E		2,500	1,750	2,000	2,200,000	1,120,000	WCLIB
2550f-1.8E		2,550	1,400	2,000	1,800,000	910,000	SPIB
2550f-2.1E		2,550	2,050	2,025	2,100,000	1,070,000	NLGA, SPIB, WCLIB, WWPA, NELMA
2700f-2.0E		2,700	1,800	2,100	2,000,000	1,020,000	WCLIB
2700f-2.2E		2,700	2,150	2,100	2,200,000	1,120,000	NLGA, SPIB, WCLIB, WWPA, NELMA
2850f-1.8E		2,850	1,600	2,100	1,800,000	910,000	SPIB
2850f-2.3E		2,850	2,300	2,150	2,300,000	1,170,000	NLGA, SPIB, WCLIB, WWPA, NELMA
3000f-2.4E		3,000	2,400	2,200	2,400,000	1,220,000	NLGA, SPIB

Table 4C (Cont.) Reference Design Values for Mechanically Graded Dimension Lumber[1,2,3]

(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

Commercial grade	Size classification	Design values in pounds per square inch (psi)					Grading Rules Agency
		Bending F_b	Tension parallel to grain F_t	Compression parallel to grain F_c	Modulus of Elasticity E	Modulus of Elasticity E_{min}	
MACHINE EVALUATED LUMBER (MEL)							
M-5		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" and less	2,000	1,200	1,825	1,800,000	840,000	NLGA, SPIB
M-19	in thickness	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" and wider	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
M-32		750	425	925	1,400,000	650,000	SPIB
M-33		850	475	975	1,400,000	650,000	SPIB
M-34		975	550	1,450	1,600,000	750,000	SPIB
M-35		1,050	575	1,500	1,600,000	750,000	SPIB
M-36		1,200	650	1,550	1,600,000	750,000	SPIB
M-37		1,250	725	1,600	1,600,000	750,000	SPIB
M-38		1,500	900	1,650	1,600,000	750,000	SPIB
M-39		1,650	1,020	1,750	1,700,000	790,000	SPIB
M-40		1,850	1,175	1,850	1,700,000	790,000	SPIB

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_v, AND COMPRESSION PERPENDICULAR TO GRAIN, $F_{c\perp}$.** Values for specific gravity, G, shear parallel to grain, F_v, and compression perpendicular to grain, $F_{c\perp}$, are provided below for MSR and MEL lumber. For species or species groups not shown below, the G, F_v, and $F_{c\perp}$ 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_v and $F_{c\perp}$ design values may be calculated in accordance with the grading rule requirements.

Species	Modulus of Elasticity E (x10^6) psi	Specific Gravity G	Design values in pounds per square inch (psi)		Grading Rules Agency
			Shear parallel to grain F_v	Compression perpendicular to grain $F_{c\perp}$	
Douglas Fir-Larch	1.0 to 1.9	0.50	180	625	WWPA
	2.0	0.51	180	670	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	1.0 to 1.9	0.50	180	625	WCLIB
	2.0	0.51	180	670	WCLIB
	2.1	0.52	180	690	
	2.2	0.53	180	715	
	2.3	0.54	180	735	
	2.4	0.55	180	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 & higher	0.57	190	715	NLGA
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
	1.5 and higher	0.46	160	555	WWPA
Hem-Fir	1.0 and higher	0.43	140	405	WCLIB
	1.0 to 1.5	0.43	150	405	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	175	670	
	2.4	0.52	180	690	
Hem-Fir (N)	1.0 and higher	0.46	145	405	NLGA
Southern Pine	1.0 to 1.7	0.55	175	565	SPIB
	1.8*	0.57*	190*	805*	SPIB
	1.9 and higher	0.57	190	805	SPIB
Spruce-Pine-Fir	1.2 to 1.7	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 (S)	1.0 to 1.1	0.36	135	335	NELMA, WCLIB, WWPA
	1.2 to 1.9	0.42	150	465	NELMA
	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, 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

* 1.8E southern pine marked with a specific gravity of 0.55 on the grade stamp has a shear parallel to grain, F_v, of 175 psi and compression perpendicular to grain, $F_{c\perp}$, of 565 psi.

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

Table 4D Adjustment Factors

Size Factor, C_F

When visually graded timbers are subjected to loads applied to the narrow face, tabulated design values shall be multiplied by the following size factors:

Size Factors, C_F

Depth	F_b	F_t	F_c
d > 12"	$(12/d)^{1/9}$	1.0	1.0
d ≤ 12"	1.0	1.0	1.0

Flat Use Factor, C_{fu}

When members classified as Beams and Stringers* in Table 4D are subjected to loads applied to the wide face, tabulated design values shall be multiplied by the following flat use factors:

Flat Use Factor, C_{fu}

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

*"Beams and Stringers" are defined in NDS 4.1.3 (also see Table 1B).

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

Table 4D Reference Design Values for Visually Graded Timbers (5" x 5" and larger)[1,3]

(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)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
ALASKA CEDAR										
Select Structural	Beams and Stringers	1,400	675	155	525	925	1,200,000	440,000	0.47	WCLIB
No.1		1,150	475	155	525	775	1,200,000	440,000		
No.2		750	300	155	525	500	1,000,000	370,000		
Select Structural	Posts and Timbers	1,300	700	155	525	975	1,200,000	440,000		
No.1		1,050	575	155	525	850	1,200,000	440,000		
No.2		625	350	155	525	600	1,000,000	370,000		
BALDCYPRESS										
Select Structural	5"x5" and Larger	1,150	750	200	615	1,050	1,300,000	470,000	0.43	SPIB
No.1		1,000	675	200	615	925	1,300,000	470,000		
No.2		625	425	175	615	600	1,000,000	370,000		
BALSAM FIR										
Select Structural	Beams and Stringers	1,350	900	125	305	950	1,400,000	510,000	0.36	NELMA
No.1		1,100	750	125	305	800	1,400,000	510,000		
No.2		725	350	125	305	500	1,100,000	400,000		
Select Structural	Posts and Timbers	1,250	825	125	305	1,000	1,400,000	510,000		
No.1		1,000	675	125	305	875	1,400,000	510,000		
No.2		575	375	125	305	400	1,100,000	400,000		
BEECH-BIRCH-HICKORY										
Select Structural	Beams and Stringers	1,650	975	180	715	975	1,500,000	550,000	0.71	NELMA
No.1		1,400	700	180	715	825	1,500,000	550,000		
No.2		900	450	180	715	525	1,200,000	440,000		
Select Structural	Posts and Timbers	1,550	1,050	180	715	1,050	1,500,000	550,000		
No.1		1,250	850	180	715	900	1,500,000	550,000		
No.2		725	475	180	715	425	1,200,000	440,000		
COAST SITKA SPRUCE										
Select Structural	Beams and Stringers	1,150	675	115	455	775	1,500,000	550,000	0.43	NLGA
No.1		950	475	115	455	650	1,500,000	550,000		
No.2		625	325	115	455	425	1,200,000	440,000		
Select Structural	Posts and Timbers	1,100	725	115	455	825	1,500,000	550,000		
No.1		875	575	115	455	725	1,500,000	550,000		
No.2		525	350	115	455	500	1,200,000	440,000		
DOUGLAS FIR-LARCH										
Dense Select Structural	Beams and Stringers	1,900	1,100	170	730	1,300	1,700,000	620,000	0.50	WCLIB
Select Structural		1,600	950	170	625	1,100	1,600,000	580,000		
Dense No. 1		1,550	775	170	730	1,100	1,700,000	620,000		
No. 1		1,350	675	170	625	925	1,600,000	580,000		
No. 2		875	425	170	625	600	1,300,000	470,000		
Dense Select Structural	Posts and Timbers	1,750	1,150	170	730	1,350	1,700,000	620,000		
Select Structural		1,500	1,000	170	625	1,150	1,600,000	580,000		
Dense No. 1		1,400	950	170	730	1,200	1,700,000	620,000		
No. 1		1,200	825	170	625	1,000	1,600,000	580,000		
No. 2		750	475	170	625	700	1,300,000	470,000		
Dense Select Structural	Beams and Stringers	1,900	1,100	170	730	1,300	1,700,000	620,000	0.50	WWPA
Select Structural		1,600	950	170	625	1,100	1,600,000	580,000		
Dense No. 1		1,550	775	170	730	1,100	1,700,000	620,000		
No. 1		1,350	675	170	625	925	1,600,000	580,000		
No. 2 Dense		1,000	500	170	730	700	1,400,000	510,000		
No. 2		875	425	170	625	600	1,300,000	470,000		
Dense Select Structural	Posts and Timbers	1,750	1,150	170	730	1,350	1,700,000	620,000		
Select Structural		1,500	1,000	170	625	1,150	1,600,000	580,000		
Dense No. 1		1,400	950	170	730	1,200	1,700,000	620,000		
No. 1		1,200	825	170	625	1,000	1,600,000	580,000		
No. 2 Dense		850	550	170	730	825	1,400,000	510,000		
No. 2		750	475	170	625	700	1,300,000	470,000		

Table 4D (Cont.) Reference Design Values for Visually Graded Timbers (5" x 5" and larger)[1,3]

(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)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
DOUGLAS FIR-LARCH (NORTH)										
Select Structural	Beams and Stringers	1,600	950	170	625	1,100	1,600,000	580,000	0.49	NLGA
No.1		1,300	675	170	625	925	1,600,000	580,000		
No.2		875	425	170	625	600	1,300,000	470,000		
Select Structural	Posts and Timbers	1,500	1,000	170	625	1,150	1,600,000	580,000		
No.1		1,200	825	170	625	1,000	1,600,000	580,000		
No.2		725	475	170	625	700	1,300,000	470,000		
DOUGLAS FIR-SOUTH										
Select Structural	Beams and Stringers	1,550	900	165	520	1,000	1,200,000	440,000	0.46	WWPA
No.1		1,300	625	165	520	850	1,200,000	440,000		
No.2		825	425	165	520	550	1,000,000	370,000		
Select Structural	Posts and Timbers	1,450	950	165	520	1,050	1,200,000	440,000		
No.1		1,150	775	165	520	925	1,200,000	440,000		
No.2		675	450	165	520	650	1,000,000	370,000		
EASTERN HEMLOCK										
Select Structural	Beams and Stringers	1,350	925	155	550	950	1,200,000	440,000	0.41	NELMA
No.1		1,150	775	155	550	800	1,200,000	440,000		
No.2		750	375	155	550	550	900,000	330,000		
Select Structural	Posts and Timbers	1,250	850	155	550	1,000	1,200,000	440,000		
No.1		1,050	700	155	550	875	1,200,000	440,000		
No.2		600	400	155	550	400	900,000	330,000		
EASTERN HEMLOCK-TAMARACK										
Select Structural	Beams and Stringers	1,400	925	155	555	950	1,200,000	440,000	0.41	NELMA
No.1		1,150	775	155	555	800	1,200,000	440,000		
No.2		750	375	155	555	500	900,000	330,000		
Select Structural	Posts and Timbers	1,300	875	155	555	1,000	1,200,000	440,000		
No.1		1,050	700	155	555	875	1,200,000	440,000		
No.2		600	400	155	555	400	900,000	330,000		
EASTERN HEMLOCK-TAMARACK (N)										
Select Structural	Beams and Stringers	1,450	850	165	555	950	1,300,000	470,000	0.47	NLGA
No.1		1,200	600	165	555	800	1,300,000	470,000		
No.2		775	400	165	555	500	1,100,000	400,000		
Select Structural	Posts and Timbers	1,350	900	165	555	1,000	1,300,000	470,000		
No.1		1,100	725	165	555	875	1,300,000	470,000		
No.2		650	425	165	555	600	1,100,000	400,000		
EASTERN SPRUCE										
Select Structural	Beams and Stringers	1,050	725	135	390	750	1,400,000	510,000	0.41	NELMA
No.1		900	600	135	390	625	1,400,000	510,000		
No.2		575	275	135	390	375	1,000,000	370,000		
Select Structural	Posts and Timbers	1,000	675	135	390	775	1,400,000	510,000		
No.1		800	550	135	390	675	1,400,000	510,000		
No.2		450	300	135	390	300	1,000,000	370,000		
EASTERN WHITE PINE										
Select Structural	Beams and Stringers	1,050	700	125	350	675	1,100,000	400,000	0.36	NELMA
No.1		875	600	125	350	575	1,100,000	400,000		
No.2		575	275	125	350	400	900,000	330,000		
Select Structural	Posts and Timbers	975	650	125	350	725	1,100,000	400,000		
No.1		800	525	125	350	625	1,100,000	400,000		
No.2		450	300	125	350	325	900,000	330,000		
HEM-FIR										
Select Structural	Beams and Stringers	1,300	750	140	405	925	1,300,000	470,000	0.43	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		

Table 4D (Cont.) Reference Design Values for Visually Graded Timbers (5" x 5" and larger)[1,3]

(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)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
HEM-FIR (NORTH)										
Select Structural	Beams and Stringers	1,250	725	135	405	900	1,300,000	470,000	0.46	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		
MIXED MAPLE										
Select Structural	Beams and Stringers	1,150	700	180	620	725	1,100,000	400,000	0.55	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		
MIXED OAK										
Select Structural	Beams and Stringers	1,350	800	155	800	825	1,000,000	370,000	0.68	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		
MIXED SOUTHERN PINE[2]		**(Wet Service Conditons)**								
Select Structural	5"x5" and Larger	1,500	1,000	165	375	900	1,300,000	470,000	0.51	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		
MOUNTAIN HEMLOCK										
Select Structural	Beams and Stringers	1,350	775	170	570	875	1,100,000	400,000	0.47	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		
NORTHERN PINE										
Select Structural	Beams and Stringers	1,250	850	135	435	850	1,300,000	470,000	0.42	NELMA
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		
NORTHERN RED OAK										
Select Structural	Beams and Stringers	1,600	950	205	885	950	1,300,000	470,000	0.68	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		
NORTHERN WHITE CEDAR										
Select Structural	Beams and Stringers	900	600	115	370	600	700,000	260,000	0.31	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		
PONDEROSA PINE										
Select Structural	Beams and Stringers	1,100	725	130	535	750	1,100,000	400,000	0.43	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		

Table 4D (Cont.) Reference Design Values for Visually Graded Timbers (5" x 5" and larger)[1,3]

(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)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
RED MAPLE										
Select Structural	Beams and Stringers	1,500	875	195	615	900	1,500,000	550,000	0.58	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		
RED OAK										
Select Structural	Beams and Stringers	1,350	800	155	820	825	1,200,000	440,000	0.67	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		
RED PINE										
Select Structural	Beams and Stringers	1,050	625	130	440	725	1,100,000	400,000	0.44	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		
REDWOOD										
Select Structural	5" x 5" and Larger	1,100	750	145	420	900	1,000,000	370,000	0.37	RIS
No. 1		950	650	145	420	800	1,000,000	370,000		
No. 2		750	400	145	420	650	900,000	330,000		
SITKA SPRUCE										
Select Structural	Beams and Stringers	1,200	675	140	435	825	1,300,000	470,000	0.43	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	0.43	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		
SOUTHERN PINE		**(Wet Service Conditons)**								
Dense Select Structural	5" x 5" and Larger	1,750	1,200	165	440	1,100	1,600,000	580,000	0.55	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		
SPRUCE-PINE-FIR										
Select Structural	Beams and Stringers	1,100	650	125	425	775	1,300,000	470,000	0.42	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		

Table 4D (Cont.) Reference Design Values for Visually Graded Timbers (5" x 5" and larger)[1,3]

(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)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
SPRUCE-PINE-FIR (SOUTH)										
Select Structural	Beams and Stringers	1,050	625	125	335	675	1,200,000	440,000	0.36	NELMA WWPA WCLIB
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		
WESTERN CEDARS										
Select Structural	Beams and Stringers	1,150	675	140	425	875	1,000,000	370,000	0.36	WCLIB WWPA
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		
WESTERN CEDARS (NORTH)										
Select Structural	Beams and Stringers	1,150	675	130	425	850	1,000,000	370,000	0.35	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		
WESTERN HEMLOCK										
Select Structural	Beams and Stringers	1,400	825	170	410	1,000	1,400,000	510,000	0.47	WCLIB WWPA
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		
WESTERN HEMLOCK (NORTH)										
Select Structural	Beams and Stringers	1,400	825	135	410	1,000	1,400,000	510,000	0.46	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		
WESTERN JUNIPER										
Select Structural	Beams and Stringers	1,300	650	115	770	325	500,000	180,000	0.42	WCLIB
No.1		1,100	450	115	770	275	500,000	180,000		
No.2		650	350	115	770	175	400,000	150,000		
Select Structural	Posts and Timbers	1,300	675	115	770	350	500,000	180,000		
No.1		1,000	550	115	770	300	500,000	180,000		
No.2		600	325	115	770	225	400,000	150,000		
WESTERN WHITE PINE										
Select Structural	Beams and Stringers	1,050	600	120	375	775	1,300,000	470,000	0.40	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		
WESTERN WOODS										
Select Structural	Beams and Stringers	1,050	625	125	345	750	1,100,000	400,000	0.36	WCLIB WWPA
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		

Table 4D (Cont.) Reference Design Values for Visually Graded Timbers (5" x 5" and larger)[1,3]

(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)							Specific Gravity[4]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
WHITE OAK										
Select Structural	Beams and Stringers	1,400	825	205	800	900	1,000,000	370,000	0.73	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

1. **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.
2. **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; 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

	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}
Conversion Factor	0.78	0.78	0.98	0.73	0.78	0.82

3. 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.
4. Specific gravity, G, based on weight and volume when oven-dry.

Table 4E Adjustment Factors

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, $C_M = 1.0$

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).

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.

Table 4E Reference Design Values for Visually Graded Decking[1,2]

(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)					Specific Gravity[3]	Grading Rules Agency
		Bending		Compression perpendicular to grain	Modulus of Elasticity			
		Single Member	Repetitive Member					
		F_b	$(F_b)(C_r)$	$F_{c\perp}$	E	E_{min}	G	
BALSAM FIR								
Select	2"-4" thick	—	1,650	—	1,500,000	550,000	0.36	NELMA
Commercial	4"-12"wide	—	1,400	—	1,300,000	470,000		
COAST SITKA SPRUCE								
Select	2"-4" thick	1,250	1,450	455	1,700,000	620,000	0.43	NLGA
Commercial	4"& wider	1,050	1,200	455	1,500,000	550,000		
COAST SPECIES								
Select	2"-4" thick	1,250	1,450	370	1,500,000	550,000	0.43	NLGA
Commercial	4"& wider	1,050	1,200	370	1,400,000	510,000		
DOUGLAS FIR-LARCH								
Select Dex	2"-4" thick	1,750	2,000	625	1,800,000	660,000	0.50	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	0.50	WWPA
Commercial	4"-12"wide	1,450	1,650	625	1,700,000	620,000		
DOUGLAS FIR-LARCH (NORTH)								
Select	2"-4" thick	1,750	2,000	625	1,800,000	660,000	0.49	NLGA
Commercial	4"& wider	1,450	1,650	625	1,700,000	620,000		
DOUGLAS FIR-SOUTH								
Selected	2"-4" thick	1,650	1,900	520	1,400,000	510,000	0.46	WWPA
Commercial	4"-12"wide	1,400	1,600	520	1,300,000	470,000		
EASTERN HEMLOCK-TAMARACK								
Select	2"-4" thick	—	1,700	—	1,300,000	470,000	0.41	NELMA
Commercial	4"-12"wide	—	1,450	—	1,100,000	400,000		
EASTERN HEMLOCK-TAMARACK (NORTH)								
Select	2"-4" thick	1,500	1,700	555	1,300,000	470,000	0.47	NLGA
Commercial	4"& wider	1,250	1,450	555	1,100,000	400,000		
EASTERN SPRUCE								
Select	2"-4" thick	—	1,300	—	1,500,000	550,000	0.41	NELMA
Commercial	4"-12"wide	—	1,100	—	1,400,000	510,000		
EASTERN WHITE PINE								
Select	2"-4" thick	—	1,300	—	1,200,000	440,000	0.36	NELMA
Commercial	4"-12"wide	—	1,100	—	1,100,000	400,000		
EASTERN WHITE PINE (NORTH)								
Select	2"-4" thick	900	1,050	350	1,200,000	440,000	0.38	NLGA
Commercial	4"& wider	775	875	350	1,100,000	400,000		
HEM-FIR								
Select Dex	2"-4" thick	1,400	1,600	405	1,500,000	550,000	0.43	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	0.43	WWPA
Commercial	4"-12"wide	1,150	1,350	405	1,400,000	510,000		
HEM-FIR (NORTH)								
Select	2"-4" thick	1,350	1,500	405	1,500,000	550,000	0.46	NLGA
Commercial	4"& wider	1,100	1,300	405	1,400,000	510,000		
NORTHERN PINE								
Select	2"-4" thick	—	1,550	—	1,400,000	510,000	0.42	NELMA
Commercial	4"-12"wide	—	1,300	—	1,300,000	470,000		
NORTHERN SPECIES								
Select	2"-4" thick	900	1,050	350	1,100,000	400,000	0.35	NLGA
Commercial	4"& wider	775	875	350	1,000,000	370,000		

Table 4E (Cont.) Reference Design Values for Visually Graded Decking[1,2]

(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)					Specific Gravity[3]	Grading Rules Agency
		Bending		Compression perpendicular to grain	Modulus of Elasticity			
		Single Member	Repetitive Member					
		F_b	$(F_b)(C_r)$	$F_{c\perp}$	E	E_{min}	G	
NORTHERN WHITE CEDAR								
Select	2"-4" thick	—	1,100	—	800,000	290,000	0.31	NELMA
Commercial	4"-12"wide	—	950	—	700,000	260,000		
PONDEROSA PINE								
Select	2"-4" thick	1,200	1,400	535	1,300,000	470,000	0.43	NLGA
Commercial	4"& wider	1,000	1,150	535	1,100,000	400,000		
RED PINE								
Select	2"-4" thick	1,150	1,350	440	1,300,000	470,000	0.44	NLGA
Commercial	4"& wider	975	1,100	440	1,200,000	440,000		
REDWOOD								
Select	2" thick	1,450	1,700	—	1,100,000	400,000	0.37	RIS
Commercial	6"& wider	1,200	1,350	—	1,000,000	370,000	0.37	
Deck Heart and Deck Common	2" thick 4" wide	400	450	420	900,000	330,000	0.37	
	2" thick 6" wide	700	800	420	900,000	330,000	0.37	
SITKA SPRUCE								
Select Dex	2"-4" thick	1,300	1,500	435	1,500,000	550,000	0.43	WCLIB
Commercial Dex	6"-8"wide	1,100	1,250	435	1,300,000	470,000		
SOUTHERN PINE		(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	0.55	SPIB
Dense Select		1,650	1,900	660	1,600,000	580,000		
Select		1,400	1,650	565	1,600,000	580,000		
Dense Commercial	2" & wider	1,650	1,900	660	1,600,000	580,000		
Commercial		1,400	1,650	565	1,600,000	580,000		
SOUTHERN PINE		(Surfaced Green – Used in any service condition)						
Dense Standard	2-1/2"-4" thick	1,600	1,800	440	1,600,000	580,000	0.55	SPIB
Dense Select		1,350	1,500	440	1,400,000	510,000		
Select		1,150	1,300	375	1,400,000	510,000		
Dense Commercial	2" & wider	1,350	1,500	440	1,400,000	510,000		
Commercial		1,150	1,300	375	1,400,000	510,000		
SPRUCE-PINE-FIR								
Select	2"-4" thick	1,200	1,400	425	1,500,000	550,000	0.42	NLGA
Commercial	4"& wider	1,000	1,150	425	1,300,000	470,000		
SPRUCE-PINE-FIR (SOUTH)								
Selected	2"-4" thick	1,150	1,350	335	1,400,000	510,000	0.36	NELMA WWPA
Commercial	4"-12"wide	950	1,100	335	1,200,000	440,000		
WESTERN CEDARS								
Select Dex	2"-4" thick	1,250	1,450	425	1,100,000	400,000	0.36	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	0.36	WWPA
Commercial	4"-12"wide	1,050	1,200	425	1,000,000	370,000		
WESTERN CEDARS (NORTH)								
Select	2"-4" thick	1,200	1,400	425	1,100,000	400,000	0.35	NLGA
Commercial	4"& wider	1,050	1,200	425	1,000,000	370,000		

Table 4E (Cont.) Reference Design Values for Visually Graded Decking[1,2]

(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)					Specific Gravity[3]	Grading Rules Agency
		Bending		Compression perpendicular to grain	Modulus of Elasticity			
		Single Member	Repetitive Member					
		F_b	$(F_b)(C_r)$	$F_{c\perp}$	E	E_{min}	G	
WESTERN HEMLOCK								
Select Dex	2"-4" thick	1,500	1,750	410	1,600,000	580,000	0.47	WCLIB
Commercial Dex	6"& wider	1,300	1,450	410	1,400,000	510,000		
WESTERN HEMLOCK (NORTH)								
Select	2"-4" thick	1,500	1,750	410	1,600,000	580,000	0.46	NLGA
Commercial	4"& wider	1,300	1,450	410	1,400,000	510,000		
WESTERN WHITE PINE								
Select	2"-4" thick	1,100	1,300	375	1,400,000	510,000	0.40	NLGA
Commercial	4"& wider	925	1,050	375	1,300,000	470,000		
WESTERN WOODS								
Selected	2"-4" thick	1,150	1,300	335	1,200,000	440,000	0.36	WWPA
Commercial	4"-12"wide	950	1,100	335	1,100,000	400,000		

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. 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.
3. Specific gravity, G, based on weight and volume when oven-dry.

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 $(F_b)(C_F) \le 1{,}150$ psi, $C_M = 1.0$

** when $(F_c)(C_F) \le 750$ 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

		F_b		F_t	F_c
		Thickness (breadth)			
Grades	Width (depth)	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)[1,3]

(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)							Specific Gravity[5]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
AUSTRIAN SPRUCE - Austria & The Czech Republic										
Select Structural	2" & wider	1,500	675	175	260	1,250	1,700,000	620,000	0.43	WCLIB
No. 1		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		
DOUGLAS FIR - France & Germany										
Select Structural	2" & wider	1,500	675	205	540	1,250	1,900,000	690,000	0.48	WCLIB
No. 1		975	450	205	540	1,100	1,700,000	620,000		
No. 2		825	375	205	540	1,000	1,500,000	550,000		
No. 3		475	225	205	540	600	1,300,000	470,000		
Stud	2" & wider	650	300	205	540	650	1,300,000	470,000		
Construction	2" - 4" wide	925	425	205	540	1,250	1,400,000	510,000		
Standard		525	225	205	540	1,050	1,300,000	470,000		
Utility		250	100	205	540	675	1,200,000	440,000		
DOUGLAS FIR/EUROPEAN LARCH - Austria, The Czech Republic, & Bavaria[2]										
Select Structural	2" & wider	1,900	850	195	440	1,400	1,800,000	660,000	0.48	WCLIB
No. 1		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		
MONTANE PINE - South Africa										
Select Structural	2" & wider	975	425	135	325	1,100	1,300,000	470,000	0.45	WCLIB
No. 1		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		
NORWAY SPRUCE - Estonia, Latvia, & Lithuania										
Select Structural	2" & wider	1,200	550	150	430	1,200	1,600,000	580,000	0.42	WCLIB
No. 1		850	375	150	430	1,050	1,400,000	510,000		
No. 2		800	350	150	430	1,000	1,300,000	470,000		
No. 3		450	200	150	430	575	1,100,000	400,000		
Stud	2" & wider	625	275	150	430	625	1,100,000	400,000		
Construction	2" - 4" wide	900	400	150	430	1,200	1,200,000	440,000		
Standard		500	225	150	430	1,050	1,100,000	400,000		
Utility		250	100	150	430	675	1,000,000	370,000		
NORWAY SPRUCE - Finland										
Select Structural	2" & wider	1,350	600	125	220	1,200	1,500,000	550,000	0.42	WCLIB
No. 1		850	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		

Table 4F (Cont.) Reference Design Values for Non-North American Visually Graded Dimension Lumber (2" - 4" thick)[1,3]

(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)							Specific Gravity[5]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
NORWAY SPRUCE - Germany, NE France, & Switzerland										
Select Structural	2" & wider	1,200	550	170	355	1,200	1,600,000	580,000	0.42	WCLIB
No. 1		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		
NORWAY SPRUCE - Norway										
Select Structural	2" & wider	1,550	700	115	360	1,250	1,800,000	660,000	0.43	WCLIB
No. 1		1,000	450	115	360	1,100	1,500,000	550,000		
No. 2		800	375	115	360	1,000	1,300,000	470,000		
No. 3		475	200	115	360	575	1,200,000	440,000		
Stud	2" & wider	625	275	115	360	650	1,200,000	440,000		
Construction	2" - 4" wide	925	425	115	360	1,250	1,200,000	440,000		
Standard		525	225	115	360	1,050	1,100,000	400,000		
Utility		250	100	115	360	675	1,100,000	370,000		
NORWAY SPRUCE - Romania & Ukraine										
Select Structural	2" & wider	1,250	575	100	275	1,200	1,500,000	550,000	0.38	WCLIB
No. 1		850	375	100	275	1,050	1,400,000	510,000		
No. 2		750	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		
NORWAY SPRUCE - Sweden										
Select Structural	2" & wider	1,250	550	170	285	1,200	1,600,000	580,000	0.42	WCLIB
No. 1		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		
SCOTS PINE - Austria & The Czech Republic, Romania, & Ukraine										
Select Structural	2" & wider	1,300	600	135	270	1,200	1,700,000	620,000	0.50	WCLIB
No. 1		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		
SCOTS PINE - Estonia, Latvia, & Lithuania										
Select Structural	2" & wider	1,150	525	130	430	1,150	1,500,000	550,000	0.45	WCLIB
No. 1		800	350	130	430	1,050	1,400,000	510,000		
No. 2		750	325	130	430	975	1,200,000	440,000		
No. 3		425	200	130	430	550	1,100,000	400,000		
Stud	2" & wider	575	275	130	430	625	1,100,000	400,000		
Construction	2" - 4" wide	850	375	130	430	1,200	1,100,000	400,000		
Standard		475	225	130	430	1,000	1,000,000	370,000		
Utility		225	100	130	430	650	1,000,000	370,000		

Table 4F (Cont.) Reference Design Values for Non-North American Visually Graded Dimension Lumber (2" - 4" thick)[1,3]

(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)							Specific Gravity[5]	Grading Rules Agency
		Bending	Tension parallel to grain	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of Elasticity			
		F_b	F_t	F_v	$F_{c\perp}$	F_c	E	E_{min}	G	
SCOTS PINE - Finland										
Select Structural	2" & wider	1,300	600	150	210	1,200	1,500,000	550,000	0.48	WCLIB
No. 1		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		
SCOTS PINE - Germany[4]										
Select Structural	2" & wider	1,200	550	160	395	1,200	1,600,000	580,000	0.53	WCLIB
No. 1		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		
SCOTS PINE - Sweden										
Select Structural	2" & wider	1,350	600	120	410	1,200	1,700,000	620,000	0.47	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		
SILVER FIR (Abies alba) - Germany. NE France, & Switzerland										
Select Structural	2" & wider	950	425	125	400	1,100	1,500,000	550,000	0.43	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		
SOUTHERN PINE - Misiones Argentina										
Select Structural	2" & wider	1,100	500	150	440	1,150	1,200,000	440,000	0.45	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		
SOUTHERN PINE - Misiones Argentina, Free of Heart Center and Medium Grain Density										
Select Structural	2" & wider	1,700	775	210	710	1,250	1,500,000	550,000	0.54	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		

See footnotes.

Footnotes to Table 4F

1. **LUMBER DIMENSIONS.** Reference 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.
2. Reference design values are applicable only for 2x4 dimensional lumber and shall not be multiplied by the size factor adjustment.
3. 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.
4. Does not include states of Baden-Wurttemburg and Saarland.
5. Specific gravity, G, based on weight and volume when oven-dry.

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 ≤ 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

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

	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	Shear Parallel to Grain	Modulus of Elasticity			Extreme Fiber in Bending	Compression Perpendicular to Grain	Shear Parallel to Grain	Modulus of Elasticity			Tension Parallel to Grain	Compression Parallel to Grain	Specific Gravity for Fastener Design
	Bottom of Beam Stressed in Tension (Positive Bending)	Top of Beam Stressed in Tension (Negative Bending)			For Deflection Calculations [11]		For Stability Calculations				For Deflection Calculations [11]		For Stability Calculations			
Stress Class	F_{bx}^{+} (psi)	F_{bx}^{-} [1] (psi)	$F_{c\perp x}$ (psi)	F_{vx} [4] (psi)	$E_{x\ true}$ (10^6 psi)	$E_{x\ app}$ (10^6 psi)	$E_{x\ min}$ (10^6 psi)	F_{by} (psi)	$F_{c\perp y}$ (psi)	F_{vy} [4][5] (psi)	$E_{y\ true}$ (10^6 psi)	$E_{y\ app}$ (10^6 psi)	$E_{y\ min}$ (10^6 psi)	F_t (psi)	F_c (psi)	G
16F-1.3E	1600	925	315	195	1.4	1.3	0.69	800	315	170	1.2	1.1	0.58	675	925	0.41
20F-1.5E	2000	1100	425	195 [6]	1.6	1.5	0.79	800	315	170	1.3	1.2	0.63	725	925	0.41
24F-1.7E	2400	1450	500	210 [6]	1.8	1.7	0.90	1050	315	185	1.4	1.3	0.69	775	1000	0.42
24F-1.8E	2400	1450 [2]	650	265 [3]	1.9	1.8	0.95	1450	560	230 [3]	1.7	1.6	0.85	1100	1600	0.50 [10]
26F-1.9E [7]	2600	1950	650	265 [3]	2.0	1.9	1.00	1600	560	230 [3]	1.7	1.6	0.85	1150	1600	0.50 [10]
28F-2.1E SP [7]	2800	2300	805	300	2.2 [9]	2.1 [9]	1.09 [9]	1600	650	260	1.8	1.7	0.90	1250	1750	0.55
30F-2.1E SP [7][8]	3000	2400	805	300	2.2 [9]	2.1 [9]	1.09 [9]	1750	650	260	1.8	1.7	0.90	1250	1750	0.55

1. For balanced layups, F_{bx}^{-} shall be equal to F_{bx}^{+} for the stress class. Designer shall specify when balanced layup is required.
2. The negative reference bending design value, F_{bx}^{-}, is permitted to be increased to 1850 psi for Douglas Fir and to 1950 psi for Southern Pine for specific combinations. Designer shall specify when these increased design values are required.
3. For structural glued laminated timber of Southern Pine, the reference shear design values, F_{vx} and F_{vy}, are permitted to be increased to 300 psi, and 260 psi, respectively.
4. The reference design values for shear, F_{vx} and F_{vy}, shall be multiplied by the shear reduction factor, C_{vr}, for the conditions defined in NDS 5.3.10.
5. Reference 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, the reference design 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).
6. Certain Southern Pine combinations may contain lumber with wane. If lumber with wane is used, the reference 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).
7. 26F, 28F, and 30F beams are not produced by all manufacturers, therefore, availability may be limited. Contact supplier or manufacturer for details.
8. 30F combinations are restricted to a maximum 6 in. nominal width unless the manufacturer has qualified for wider widths based on full-scale tests subject to approval by an accredited inspection agency.
9. For 28F and 30F members with more than 15 laminations, $E_{x\ true} = 2.1 \times 10^6$ psi, $E_{x\ app} = 2.0 \times 10^6$ psi, and $E_{x\ min} = 1.06 \times 10^6$ psi.
10. For structural glued laminated timber of Southern Pine, specific gravity for fastener design is permitted to be increased to 0.55.
11. Notations:
    $E_{x\ app}$, $E_{y\ app}$ = Apparent moduli of elasticity in the X-X and Y-Y directions, respectively, for use in beam deflection calculations. $E_{x\ app}$ and $E_{y\ app}$ correspond to reference moduli of elasticity E_x and E_y, respectively, as defined in NDS 5.2.7.
    $E_{x\ true}$, $E_{y\ true}$ = Shear-free moduli of elasticity in the X-X and Y-Y directions, respectively, for use in beam deflection calculations when shear deflection is required to be considered separately from bending deflection, such as when the span-to-depth ratio of the beam is small.

Stress classes represent groups of similar glued laminated timber combinations. Values for individual combinations are included in Table 5A - Expanded. Reference 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 manufacturer for availability.

Table 5A Expanded - Reference Design Values for Structural Glued Laminated Softwood Timber Combinations[1]

(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

		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	
		Bending		Compression Perpendicular to Grain		Shear Parallel to Grain	Modulus of Elasticity			Bending	Compression Perpendicular to Grain	Shear Parallel to Grain	Modulus of Elasticity			Tension Parallel to Grain	Compression Parallel to Grain	Specific Gravity for Fastener Design	
		Bottom of beam Stressed in tension (Positive Bending)	Top of Beam Stressed in Tension (Negative Bending)	Tension Face	Compression Face		For Deflection Calculations[6]		For Stability Calculations				For Deflection Calculations[6]		For Stability Calculations			Top or Bottom Face	Side Face
Combination Symbol	Species Outer/ Core	F_{bx}^{+} (psi)	F_{bx}^{-} (psi)	$F_{c\perp x}$ (psi)		F_{vx}[2] (psi)	$E_{x\ true}$ (10^6 psi)	$E_{x\ app}$ (10^6 psi)	$E_{x\ min}$ (10^6 psi)	F_{by} (psi)	$F_{c\perp y}$ (psi)	F_{vy}[3] (psi)	$E_{y\ true}$ (10^6 psi)	$E_{y\ app}$ (10^6 psi)	$E_{y\ min}$ (10^6 psi)	F_t (psi)	F_c (psi)	G	
16F-1.3E		**1600**	**925**	**315**		**195**	**1.4**	**1.3**	**0.69**	**800**	**315**	**170**	**1.2**	**1.1**	**0.58**	**675**	**925**	**0.41**	
16F-V3	DF/DF	1600	1250	560	560	265	1.6	1.5	0.79	1450	560	230	1.6	1.5	0.79	975	1500	0.50	0.50
16F-V6	DF/DF	1600	1600	560	560	265	1.7	1.6	0.85	1450	560	230	1.6	1.5	0.79	1000	1600	0.50	0.50
16F-E2	HF/HF	1600	1050	375	375	215	1.5	1.4	0.74	1200	375	190	1.4	1.3	0.69	825	1150	0.43	0.43
16F-E3	DF/DF	1600	1200	560	560	265	1.7	1.6	0.85	1400	560	230	1.6	1.5	0.79	975	1600	0.50	0.50
16F-E6	DF/DF	1600	1600	560	560	265	1.7	1.6	0.85	1550	560	230	1.6	1.5	0.79	1000	1600	0.50	0.50
16F-E7	HF/HF	1600	1600	375	375	215	1.5	1.4	0.74	1350	375	190	1.4	1.3	0.74	875	1250	0.43	0.43
16F-V2	SP/SP	1600	1400	740	650	300	1.6	1.5	0.79	1450	650	260	1.5	1.4	0.74	1000	1300	0.55	0.55
16F-V3	SP/SP	1600	1450	740	740	300	1.5	1.4	0.74	1450	650	260	1.5	1.4	0.74	975	1400	0.55	0.55
16F-V5	SP/SP	1600	1600	650	650	300	1.7	1.6	0.85	1600	650	260	1.6	1.5	0.79	1000	1550	0.55	0.55
16F-E1	SP/SP	1600	1250	650	650	300	1.7	1.6	0.85	1400	650	260	1.7	1.6	0.85	1050	1550	0.55	0.55
16F-E3	SP/SP	1600	1600	650	650	300	1.8	1.7	0.90	1650	650	260	1.7	1.6	0.85	1100	1550	0.55	0.55
20F-1.5E		**2000**	**1100**	**425**		**195**	**1.6**	**1.5**	**0.79**	**800**	**315**	**170**	**1.3**	**1.2**	**0.63**	**725**	**925**	**0.41**	
20F-V3	DF/DF	2000	1450	650	560	265	1.7	1.6	0.85	1450	560	230	1.6	1.5	0.79	1000	1550	0.50	0.50
20F-V7	DF/DF	2000	2000	650	650	265	1.7	1.6	0.85	1450	560	230	1.7	1.6	0.85	1050	1600	0.50	0.50
20F-V12	AC/AC	2000	1400	560	560	265	1.6	1.5	0.79	1250	470	230	1.5	1.4	0.74	925	1500	0.46	0.46
20F-V13	AC/AC	2000	2000	560	560	265	1.6	1.5	0.79	1250	470	230	1.5	1.4	0.74	950	1550	0.46	0.46
20F-V14	POC/POC	2000	1450	560	560	265	1.6	1.5	0.79	1300	470	230	1.5	1.4	0.74	900	1600	0.46	0.46
20F-V15	POC/POC	2000	2000	560	560	265	1.6	1.5	0.79	1300	470	230	1.5	1.4	0.74	900	1600	0.46	0.46
20F-E2	HF/HF	2000	1400	500	500	215	1.7	1.6	0.85	1200	375	190	1.5	1.4	0.74	925	1350	0.43	0.43
20F-E3	DF/DF	2000	1200	560	560	265	1.8	1.7	0.90	1400	560	230	1.7	1.6	0.85	1050	1600	0.50	0.50
20F-E6	DF/DF	2000	2000	560	560	265	1.8	1.7	0.90	1550	560	230	1.7	1.6	0.85	1150	1650	0.50	0.50
20F-E7	HF/HF	2000	2000	500	500	215	1.8	1.6	0.85	1450	375	190	1.5	1.4	0.74	1050	1450	0.43	0.43
20F-E8	ES/ES	2000	1300	450	450	200	1.6	1.5	0.79	1000	315	175	1.5	1.4	0.74	825	1100	0.41	0.41
24F-E/SPF1	SPF/SPF	2400	2400	560	560	215	1.7	1.6	0.85	1150	470	190	1.7	1.6	0.85	1150	2000	0.42	0.42
24F-E/SPF3	SPF/SPF	2400	1550	560	650	215	1.7	1.6	0.85	1200	470	195	1.6	1.5	0.79	900	1750	0.42	0.42
20F-V2	SP/SP	2000	1550	740	650	300	1.6	1.5	0.79	1450	650	260	1.5	1.4	0.74	1000	1400	0.55	0.55
20F-V3	SP/SP	2000	1450	650	650	300	1.6	1.5	0.79	1600	650	260	1.6	1.5	0.79	1000	1400	0.55	0.55
20F-V5	SP/SP	2000	2000	740	740	300	1.7	1.6	0.85	1450	650	260	1.5	1.4	0.74	1050	1500	0.55	0.55
20F-E1	SP/SP	2000	1300	650	650	300	1.8	1.7	0.90	1400	650	260	1.7	1.6	0.85	1050	1550	0.55	0.55
20F-E3	SP/SP	2000	2000	650	650	300	1.8	1.7	0.90	1700	650	260	1.7	1.6	0.85	1150	1600	0.55	0.55
24F-1.7E		**2400**	**1450**	**500**		**210**	**1.8**	**1.7**	**0.90**	**1050**	**315**	**185**	**1.4**	**1.3**	**0.69**	**775**	**1000**	**0.42**	
24F-V5	DF/HF	2400	1600	650	650	215	1.8	1.7	0.90	1350	375	200	1.6	1.5	0.79	1100	1450	0.50	0.43
24F-V10	DF/HF	2400	2400	650	650	215	1.9	1.8	0.95	1450	375	200	1.6	1.5	0.79	1150	1550	0.50	0.43
24F-E11	HF/HF	2400	2400	500	500	215	1.9	1.8	0.95	1550	375	190	1.6	1.5	0.79	1150	1550	0.43	0.43
24F-E15	HF/HF	2400	1600	500	500	215	1.9	1.8	0.95	1200	375	190	1.6	1.5	0.79	975	1500	0.43	0.43
24F-V1	SP/SP	2400	1750	740	650	300	1.8	1.7	0.90	1450	650	260	1.6	1.5	0.79	1100	1500	0.55	0.55
24F-V4[4]	SP/SP	2400	1650	740	650	210	1.8	1.7	0.90	1350	470	230	1.6	1.5	0.79	975	1350	0.55	0.43
24F-V5	SP/SP	2400	2400	740	740	300	1.8	1.7	0.90	1700	650	260	1.7	1.6	0.85	1150	1600	0.55	0.55

Table 5A (Cont.) Expanded - Reference Design Values for Structural Glued Laminated Softwood Timber Combinations[1]

(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

		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	
		Bending		Compression Perpendicular to Grain		Shear Parallel to Grain	Modulus of Elasticity			Bending	Compression Perpendicular to Grain	Shear Parallel to Grain	Modulus of Elasticity			Tension Parallel to Grain	Compression Parallel to Grain	Specific Gravity for Fastener Design	
		Bottom of beam Stressed in tension (Positive Bending)	Top of Beam Stressed in Tension (Negative Bending)	Tension Face	Compression Face		For Deflection Calculations[8]		For Stability Calculations				For Deflection Calculations[8]		For Stability Calculations			Top or Bottom Face	Side Face
Combination Symbol	Species Outer/ Core	F_{bx}^+ (psi)	F_{bx}^- (psi)	$F_{c\perp x}$ (psi)		F_{vx} [2] (psi)	$E_{x\ true}$ (10^6 psi)	$E_{x\ app}$ (10^6 psi)	$E_{x\ min}$ (10^6 psi)	F_{by} (psi)	$F_{c\perp y}$ (psi)	F_{vy} [3] (psi)	$E_{y\ true}$ (10^6 psi)	$E_{y\ app}$ (10^6 psi)	$E_{y\ min}$ (10^6 psi)	F_t (psi)	F_c (psi)	G	
24F-1.8E		**2400**	**1450**	**650**		**265**	**1.9**	**1.8**	**0.95**	**1450**	**560**	**230**	**1.7**	**1.6**	**0.85**	**1100**	**1600**	**0.50**	
24F-V4	DF/DF	2400	1850	650	650	265	1.9	1.8	0.95	1450	560	230	1.7	1.6	0.85	1100	1650	0.50	0.50
24F-V8	DF/DF	2400	2400	650	650	265	1.9	1.8	0.95	1550	560	230	1.7	1.6	0.85	1100	1650	0.50	0.50
24F-E4	DF/DF	2400	1450	650	650	265	1.9	1.8	0.95	1400	560	230	1.8	1.7	0.90	1100	1700	0.50	0.50
24F-E13	DF/DF	2400	2400	650	650	265	1.9	1.8	0.95	1750	560	230	1.8	1.7	0.90	1250	1700	0.50	0.50
24F-E18	DF/DF	2400	2400	650	650	265	1.9	1.8	0.95	1550	560	230	1.8	1.7	0.90	975	1700	0.50	0.50
24F-V3	SP/SP	2400	2000	740	740	300	1.9	1.8	0.95	1700	650	260	1.7	1.6	0.85	1150	1650	0.55	0.55
24F-V8	SP/SP	2400	2400	740	740	300	1.9	1.8	0.95	1700	650	260	1.7	1.6	0.85	1150	1650	0.55	0.55
24F-E1	SP/SP	2400	1450	805	650	300	1.9	1.8	0.95	1550	650	260	1.8	1.7	0.90	1150	1600	0.55	0.55
24F-E4	SP/SP	2400	2400	805	805	300	2.0	1.9	1.00	1850	650	260	1.9	1.8	0.95	1450	1750	0.55	0.55
26F-1.9E [5]		**2600**	**1950**	**650**		**265**	**2.0**	**1.9**	**1.00**	**1600**	**560**	**230**	**1.7**	**1.6**	**0.85**	**1150**	**1600**	**0.50**	
26F-V1	DF/DF	2600	1950	650	650	265	2.1	2.0	1.06	1850	560	230	1.9	1.8	0.95	1350	1850	0.50	0.50
26F-V2	DF/DF	2600	2600	650	650	265	2.1	2.0	1.06	1850	560	230	1.9	1.8	0.95	1350	1850	0.50	0.50
26F-V1	SP/SP	2600	2000	740	740	300	1.9	1.8	0.95	1700	650	260	1.7	1.6	0.85	1150	1600	0.55	0.55
26F-V2	SP/SP	2600	2100	740	740	300	2.0	1.9	1.00	1950	740	260	1.9	1.8	0.95	1300	1850	0.55	0.55
26F-V3	SP/SP	2600	2100	740	740	300	2.0	1.9	1.00	1950	650	260	1.9	1.8	0.95	1250	1800	0.55	0.55
26F-V4	SP/SP	2600	2600	740	740	300	2.0	1.9	1.00	1700	650	260	1.9	1.8	0.95	1200	1600	0.55	0.55
26F-V5	SP/SP	2600	2600	740	740	300	2.0	1.9	1.00	1950	650	260	1.9	1.8	0.95	1300	1850	0.55	0.55
28F-2.1E SP [5]		**2800**	**2300**	**805**		**300**	**2.2 [7]**	**2.1 [7]**	**1.11[7]**	**1600**	**650**	**260**	**1.8**	**1.7**	**0.90**	**1250**	**1750**	**0.55**	
28F-E1	SP/SP	2800	2300	805	805	300	2.2 [7]	2.1 [7]	1.11[7]	1600	650	260	1.8	1.7	0.90	1300	1850	0.55	0.55
28F-E2	SP/SP	2800	2800	805	805	300	2.2 [7]	2.1 [7]	1.11[7]	2000	650	260	1.8	1.7	0.90	1300	1850	0.55	0.55
30F-2.1E SP [5][6]		**3000**	**2400**	**805**		**300**	**2.2 [7]**	**2.1 [7]**	**1.11[7]**	**1750**	**650**	**260**	**1.8**	**1.7**	**0.90**	**1250**	**1750**	**0.55**	
30F-E1	SP/SP	3000	2400	805	805	300	2.2 [7]	2.1 [7]	1.11[7]	1750	650	260	1.8	1.7	0.90	1250	1750	0.55	0.55
30F-E2	SP/SP	3000	3000	805	805	300	2.2 [7]	2.1 [7]	1.11[7]	1750	650	260	1.8	1.7	0.90	1350	1750	0.55	0.55

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, reference design values are tabulated for loading both perpendicular and parallel to the wide faces of the laminations. For combinations and reference 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 reference design values for shear, F_{vx} and F_{vy}, shall be multiplied by the shear reduction factor, C_{vr}, for the conditions defined in NDS 5.3.10.
3. Reference design values are for structural glued laminated timbers with laminations made from a single piece of lumber across the width or multiple pieces that have been edge bonded. For structural glued laminated 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 2.
4. This combination may contain lumber with wane. If lumber with wane is used, the reference 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 2.
5. 26F, 28F, and 30F beams are not produced by all manufacturers, therefore, availability may be limited. Contact supplier or manufacturer for details.
6. 30F combinations are restricted to a maximum 6 in. nominal width unless the manufacturer has qualified for wider widths based on full-scale tests subject to approval by an accredited inspection agency.
7. For 28F and 30F members with more than 15 laminations, E_x = 2.0 million psi and E_{xmin} = 1.06 million psi.
8. Notations: $E_{x\ app}$, $E_{y\ app}$ = Apparent moduli of elasticity in the X-X and Y-Y directions, respectively, for use in beam deflection calculations. $E_{x\ app}$ and $E_{y\ app}$ correspond to reference moduli of elasticity E_x and E_y, respectively, as defined in NDS 5.2.7.
   $E_{x\ true}$, $E_{y\ true}$ = Shear-free moduli of elasticity in the X-X and Y-Y directions, respectively, for use in beam deflection calculations when shear deflection is required to be considered separately from bending deflection, such as when the span-to-depth ratio of the beam is small.

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) (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

Combination Symbol	Species	Grade	All Loading: Modulus of Elasticity[6] For Deflection Calculations E_{axial} (10^6 psi)	All Loading: Modulus of Elasticity[6] 0.95 E_{axial} (10^6 psi)	All Loading: Modulus of Elasticity[6] For Stability Calculations $E_{axial\ min}$ (10^6 psi)	All Loading: Compression Perpendicular to Grain $F_{c\perp}$ (psi)	Axially Loaded: Tension Parallel to Grain 2 or More Laminations F_t (psi)	Axially Loaded: Compression Parallel to Grain 4 or More Laminations F_c (psi)	Axially Loaded: Compression Parallel to Grain 2 or 3 Laminations F_c (psi)	Bending about Y-Y Axis, Loaded Parallel to Wide Faces of Laminations: Bending 4 or More Laminations F_{by} (psi)	Bending 3 Laminations F_{by} (psi)	Bending 2 Laminations F_{by} (psi)	Shear Parallel to Grain[1][2][3] F_{vv} (psi)	Bending About X-X Axis, Loaded Perpendicular to Wide Faces of Laminations: Bending 2 Laminations to 15 in. Deep[4] F_{bx} (psi)	Shear Parallel to Grain[3] F_{vx} (psi)	Fasteners: Specific Gravity for Fastener Design G
Visually Graded Western Species																
1	DF	L3	1.6	1.5	0.79	560	950	1550	1250	1450	1250	1000	230	1250	265	0.50
2	DF	L2	1.7	1.6	0.85	560	1250	1950	1600	1800	1600	1300	230	1700	265	0.50
3	DF	L2D	2.0	1.9	1.00	650	1450	2300	1900	2100	1850	1550	230	2000	265	0.50
4	DF	L1CL	2.0	1.9	1.00	590	1400	2100	1950	2200	2000	1650	230	2100	265	0.50
5	DF	L1	2.1	2.0	1.06	650	1650	2400	2100	2400	2100	1800	230	2200	265	0.50
14	HF	L3	1.4	1.3	0.69	375	800	1100	1050	1200	1050	850	190	1100	215	0.43
15	HF	L2	1.5	1.4	0.74	375	1050	1350	1350	1500	1350	1100	190	1450	215	0.43
16	HF	L1	1.7	1.6	0.85	375	1200	1500	1500	1750	1550	1300	190	1600	215	0.43
17	HF	L1D	1.8	1.7	0.90	500	1400	1750	1750	2000	1850	1550	190	1900	215	0.43
22[5]	SW	L3	1.1	1.0	0.53	315	525	850	725	800	700	575	170	725	195	0.35
69	AC	L3	1.3	1.2	0.63	470	725	1150	1100	1100	975	775	230	1000	265	0.46
70	AC	L2	1.4	1.3	0.69	470	975	1450	1450	1400	1250	1000	230	1350	265	0.46
71	AC	L1D	1.7	1.6	0.85	560	1250	1900	1900	1850	1650	1400	230	1750	265	0.46
72	AC	L1S	1.7	1.6	0.85	560	1250	1900	1900	1850	1650	1400	230	1900	265	0.46
73	POC	L3	1.4	1.3	0.69	470	775	1500	1200	1200	1050	825	230	1050	265	0.46
74	POC	L2	1.5	1.4	0.74	470	1050	1900	1550	1450	1300	1100	230	1400	265	0.46
75	POC	L1D	1.8	1.7	0.90	560	1350	2300	2050	1950	1750	1500	230	1850	265	0.46
Visually Graded Southern Pine																
47	SP	N2M12	1.5	1.4	0.74	650	1200	1900	1150	1750	1550	1300	260	1400	300	0.55
47 1:10	SP	N2M10	1.5	1.4	0.74	650	1150	1700	1150	1750	1550	1300	260	1400	300	0.55
47 1:8	SP	N2M	1.5	1.4	0.74	650	1000	1500	1150	1600	1550	1300	260	1400	300	0.55
48	SP	N2D12	1.8	1.7	0.90	740	1400	2200	1350	2000	1800	1500	260	1600	300	0.55
48 1:10	SP	N2D10	1.8	1.7	0.90	740	1350	2000	1350	2000	1800	1500	260	1600	300	0.55
48 1:8	SP	N2D	1.8	1.7	0.90	740	1150	1750	1350	1850	1800	1500	260	1600	300	0.55
49	SP	N1M16	1.8	1.7	0.90	650	1350	2100	1450	1950	1750	1500	260	1800	300	0.55
49 1:14	SP	N1M14	1.8	1.7	0.90	650	1350	2000	1450	1950	1750	1500	260	1800	300	0.55
49 1:12	SP	N1M12	1.8	1.7	0.90	650	1300	1900	1450	1950	1750	1500	260	1800	300	0.55
49 1:10	SP	N1M	1.8	1.7	0.90	650	1150	1700	1450	1850	1750	1500	260	1800	300	0.55
50	SP	N1D14	2.0	1.9	1.00	740	1550	2300	1700	2300	2100	1750	260	2100	300	0.55
50 1:12	SP	N1D12	2.0	1.9	1.00	740	1500	2200	1700	2300	2100	1750	260	2100	300	0.55
50 1:10	SP	N1D	2.0	1.9	1.00	740	1350	2000	1700	2100	2100	1750	260	2100	300	0.55

1. For members with 2 or 3 laminations, the reference shear design value for transverse loads parallel to the wide faces of the laminations, F_{vy}, shall be reduced by multiplying by a factor of 0.84 or 0.95, respectively.
2. The reference shear design value for transverse loads applied parallel to the wide faces of the laminations, F_{vy}, 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 reference shear design value, F_{vy}, 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 adjustments in footnotes 1 and 3.
3. The reference design values for shear, F_{vx} and F_{vy}, shall be multiplied by the shear reduction factor, C_{vr}, for the conditions defined in NDS 5.3.10.
4. For members greater than 15 in. deep, the reference bending design value, F_{bx}, shall be reduced by multiplying by a factor of 0.88.
5. When Western Cedars, Western Cedars (North), Western Woods, and Redwood (open grain) are used in combinations for Softwood Species (SW), the reference design value for modulus of elasticity, E, shall be reduced by 100,000 psi and E_{min} shall be reduced by 52,800 psi. When Coast Sitka Spruce, Coast Species, Western White Pine, and Eastern White Pine are used in combinations for Softwood Species (SW) reference design values for shear parallel to grain, F_{vx} and F_{vy}, shall be reduced by 10 psi, before applying any other adjustments.
6. Notations: E_{axial} = Axial moduli of elasticity for use in axial deformation calculation for compression and tension members as defined by NDS 5.2.7 (E_{axial} is equal to $E_{x\ true}$ and $E_{y\ true}$ as defined in Tables 5A and 5A Extended when layups are used as beams).
   0.95 E_{axial} = Apparent moduli of elasticity in either the X-X or Y-Y direction for use in beam deflection calculations when layups are used as beams.
   $E_{axial\ min}$ = Minimum axial moduli of elasticity for use in column stability calculations.

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:

$$C_V = (21/L)^{1/10}\,(12/d)^{1/10}\,(5.125/b)^{1/10} \leq 1.0$$

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 ≤ 10.75".

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 5C Reference Design Values for Structural Glued Laminated Hardwood Timber[1]

(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 5C Adjustment Factors

	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[3]
	Bending		Compression Perpendicular to Grain	Shear Parallel to Grain (Horizontal)	Modulus of Elasticity		Bending	Compression Perpendicular to Grain	Shear Parallel to Grain (Horizontal)	Modulus of Elasticity		Tension Parallel to Grain	Compression Parallel to Grain	Specific Gravity for Fastener Design
	Bottom of Beam Stressed in Tension (Positive Bending)	Top of Beam Stressed in Tension (Negative Bending)			For Deflection Calculations	For Stability Calculations				For Deflection Calculations	For Stability Calculations			
Combination Symbol	F_{bx}^{+} (psi)	F_{bx}^{-} (psi)	$F_{c\perp x}$ (psi)	F_{vx} (psi)	E_x (10^6 psi)	$E_{x\,min}$ (10^6 psi)	F_{by} (psi)	$F_{c\perp y}$ (psi)	F_{vy}[2] (psi)	E_y (10^6 psi)	$E_{y\,min}$ (10^6 psi)	F_t (psi)	F_c (psi)	G
Visually Graded Hardwoods														
12F-V1	1200	600	285	125	1.2	0.63	1050	285	110	1.0	0.53	600	800	0.39
12F-V2	1200	1200	285	125	1.2	0.63	1050	285	110	1.1	0.58	625	860	0.39
14F-V1	1400	700	405	155	1.3	0.69	1250	405	135	1.1	0.58	700	950	0.45
14F-V2	1400	700	590	180	1.3	0.69	1450	590	160	1.1	0.58	750	1200	0.53
14F-V3	1400	1400	405	155	1.3	0.69	1250	405	135	1.1	0.58	725	950	0.45
14F-V4	1400	1400	590	180	1.3	0.69	1450	590	160	1.1	0.58	775	1200	0.53
16F-V1	1600	800	590	180	1.4	0.74	1400	590	160	1.2	0.63	800	1200	0.53
16F-V2	1600	800	835	200	1.5	0.79	1700	835	175	1.3	0.69	875	1250	0.63
16F-V3	1600	1600	590	180	1.4	0.74	1400	590	160	1.2	0.63	850	1200	0.53
16F-V4	1600	1600	835	200	1.6	0.85	1700	835	175	1.3	0.69	900	1300	0.63
20F-V1	2000	1000	835	200	1.7	0.90	1700	835	175	1.4	0.74	975	1400	0.63
20F-V2	2000	2000	835	200	1.7	0.90	1700	835	175	1.4	0.74	1000	1400	0.63
E-Rated Hardwoods														
16F-E1	1600	800	440	125	1.4	0.74	1250	285	110	1.2	0.63	825	975	0.39
16F-E2	1600	1600	440	125	1.4	0.74	1400	285	110	1.2	0.63	900	1000	0.39
20F-E1	2000	1000	590	155	1.6	0.85	1350	405	135	1.3	0.69	950	1050	0.45
20F-E2	2000	2000	590	155	1.6	0.85	1600	405	135	1.3	0.69	1050	1100	0.45
24F-E1	2400	1200	770	180	1.8	0.95	1550	590	160	1.5	0.79	1050	1400	0.53
24F-E2	2400	2400	770	180	1.8	0.95	1650	590	160	1.5	0.79	1050	1400	0.53
24F-E3 YP	2400	1200	590	155	1.8	0.95	1450	405	135	1.5	0.79	975	1200	0.45
24F-E4 RM	2400	1200	895	220	1.8	0.95	1650	710	195	1.6	0.85	1050	1350	0.53
24F-E5 RO	2400	1200	1075	235	1.8	0.95	1700	900	205	1.5	0.79	1100	1450	0.63

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, reference design values are tabulated for loading both perpendicular and parallel to the wide faces of the laminations. For combinations and reference design values for members loaded primarily axially or parallel to the wide faces of the laminations, see Table 5D. For members with 2 or 3 laminations, see Table 5D.
2. Reference 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:

$$C_V = (21/L)^{1/10} (12/d)^{1/10} (5.125/b)^{1/10} \leq 1.0$$

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 ≤ 10.75".

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 5D Reference Design Values for Structural Glued Laminated Hardwood Timber

(Members stressed primarily in axial tension or compression) (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: Modulus of Elasticity, For Deflection Calculations E (10^6 psi)	All Loading: Modulus of Elasticity, For Stability Calculations E_{min} (10^6 psi)	All Loading: Compression Perpendicular to Grain $F_{c\perp}$ (psi)	Axially Loaded: Tension Parallel to Grain, 2 or More Laminations F_t (psi)	Axially Loaded: Compression Parallel to Grain, 4 or More Laminations F_c (psi)	Axially Loaded: Compression Parallel to Grain, 2 or 3 Laminations F_c (psi)	Bending about Y-Y Axis, Loaded Parallel to Wide Faces of Laminations, Bending, 4 or More Laminations F_{by} (psi)	Bending about Y-Y Axis, Loaded Parallel to Wide Faces of Laminations, Bending, 3 Laminations F_{by} (psi)	Bending about Y-Y Axis, Loaded Parallel to Wide Faces of Laminations, Bending, 2 Laminations F_{by} (psi)	Bending about Y-Y Axis, Loaded Parallel to Wide Faces of Laminations, Shear Parallel to Grain[(1)(2)] 4 or More Laminations F_{vy} (psi)	Bending About X-X Axis, Loaded Perpendicular to Wide Faces of Laminations, Bending, 2 Laminations to 15 in. Deep[(3)] F_{bx} (psi)	Bending About X-X Axis, Loaded Perpendicular to Wide Faces of Laminations, Shear Parallel to Grain F_{vx} (psi)	Fasteners: Specific Gravity for Fastener Design G
Visually Graded Hardwoods															
H1	A	N3	1.3	0.67	835	425	900	900	1250	1100	875	175	925	200	0.63
H2	A	N2	1.5	0.78	835	875	1300	1300	1700	1550	1300	175	1200	200	0.63
H3	A	N1	1.7	0.88	835	1000	1450	1450	2000	1800	1550	175	1600	200	0.63
H4	A	SS	1.7	0.88	835	1150	1600	1600	2000	1850	1600	175	1700	200	0.63
H5	B	N3	1.2	0.62	590	350	800	800	1050	900	750	160	750	180	0.53
H6	B	N2	1.3	0.67	590	750	1150	1150	1450	1300	1050	160	1000	180	0.53
H7	B	N1	1.5	0.78	590	850	1300	1300	1650	1500	1300	160	1350	180	0.53
H8	B	SS	1.5	0.78	590	950	1450	1450	1700	1550	1350	160	1400	180	0.53
H9	C	N3	1.0	0.52	405	300	625	625	900	800	625	135	675	155	0.45
H10	C	N2	1.2	0.62	405	625	900	900	1200	1100	925	135	875	155	0.45
H11	C	N1	1.3	0.67	405	725	1000	1000	1400	1300	1100	135	1150	155	0.45
H12	C	SS	1.3	0.67	405	825	1100	1100	1450	1350	1150	135	1200	155	0.45
H13	D	N3	0.9	0.47	285	250	575	575	775	675	550	110	575	125	0.39
H14	D	N2	1.1	0.57	285	550	825	825	1050	950	800	110	750	125	0.39
H15	D	N1	1.2	0.62	285	625	925	925	1200	1100	950	110	1000	125	0.39
H16	D	SS	1.2	0.62	285	700	1050	1050	1250	1150	1000	110	1050	125	0.39

Table 5D (Cont.) Reference Design Values for Structural Glued Laminated Hardwood Timber

(Members stressed primarily in axial tension or compression) (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: Modulus of Elasticity, For Deflection Calculations E (10^6 psi)	All Loading: Modulus of Elasticity, For Stability Calculations E_{min} (10^6 psi)	All Loading: Compression Perpendicular to Grain $F_{c\perp}$ (psi)	Axially Loaded: Tension Parallel to Grain, 2 or More Laminations F_t (psi)	Axially Loaded: Compression Parallel to Grain, 4 or More Laminations F_c (psi)	Axially Loaded: Compression Parallel to Grain, 2 or 3 Laminations F_c (psi)	Bending about Y-Y Axis, Loaded Parallel to Wide Faces of Laminations: Bending, 4 or More Laminations F_{by} (psi)	Bending about Y-Y Axis, Loaded Parallel to Wide Faces of Laminations: Bending, 3 Laminations F_{by} (psi)	Bending about Y-Y Axis, Loaded Parallel to Wide Faces of Laminations: Bending, 2 Laminations F_{by} (psi)	Bending about Y-Y Axis, Loaded Parallel to Wide Faces of Laminations: Shear Parallel to Grain[1][2] 4 or More Laminations F_{vy} (psi)	Bending About X-X Axis, Loaded Perpendicular to Wide Faces of Laminations: Bending, 2 Laminations to 15 in. Deep[3] F_{bx} (psi)	Bending About X-X Axis, Loaded Perpendicular to Wide Faces of Laminations: Shear Parallel to Grain F_{vx} (psi)	Fasteners: Specific Gravity for Fastener Design G
E-Rated Hardwoods															
H17	A	1.5E3	1.4	0.73	1015	1000	1500	1350	1850	1750	1550	175	1200	200	0.63
H18	A	1.8E3	1.7	0.88	1015	1150	1950	1850	2100	2000	1750	175	1450	200	0.63
H19	A	1.8E6	1.7	0.88	1015	1450	2000	1900	2300	2200	1950	175	1650	200	0.63
H20	A	2.0E3	1.9	0.98	1015	1350	2600	2200	2400	2300	2100	175	1700	200	0.63
H21	A	2.0E6	1.9	0.98	1015	1700	2430	2300	2400	2400	2300	175	2100	200	0.63
H22	B	1.5E3	1.4	0.73	770	1000	1500	1350	1850	1750	1550	160	1200	180	0.53
H23	B	1.8E3	1.7	0.88	770	1150	1950	1850	2100	2000	1750	160	1450	180	0.53
H24	B	1.8E6	1.7	0.88	770	1450	2000	1900	2300	2200	1950	160	1650	180	0.53
H25	B	2.0E3	1.9	0.98	770	1350	2300	2200	2400	2300	2100	160	1700	180	0.53
H26	B	2.0E6	1.9	0.98	770	1700	2400	2300	2400	2400	2300	160	2100	180	0.53
H27	C	1.5E3	1.4	0.73	590	1000	1500	1350	1850	1750	1550	135	1200	155	0.45
H28	C	1.8E3	1.7	0.88	590	1150	1950	1850	2100	2000	1750	135	1450	155	0.45
H29	C	1.8E6	1.7	0.88	590	1450	2000	1900	2300	2200	1950	135	1650	155	0.45
H30	C	2.0E3	1.9	0.98	590	1350	2300	2200	2400	2300	2100	135	1700	155	0.45
H31	C	2.0E6	1.9	0.98	590	1700	2400	2300	2400	2400	2300	135	2100	155	0.45
H32	D	1.5E3	1.4	0.73	440	1000	1500	1350	1850	1750	1550	110	1200	125	0.39
H33	D	1.5E6	1.4	0.73	440	1250	1500	1400	2000	1900	1700	110	1250	125	0.39
H34	D	1.8E3	1.7	0.88	440	1150	1950	1850	2100	2000	1750	110	1450	125	0.39
H35	D	1.8E6	1.7	0.88	440	1450	2000	1900	2300	2200	1950	110	1650	125	0.39
H36	D	2.0E3	1.9	0.98	440	1350	2300	2200	2400	2300	2100	110	1700	125	0.39
H37	D	2.0E6	1.9	0.98	440	1700	2400	2300	2400	2400	2300	110	2100	125	0.39

1. For members with 2 or 3 laminations, the reference shear design value for transverse loads parallel to the wide faces of the laminations, F_{vy}, shall be reduced by multiplying by a factor of 0.84 or 0.95, respectively.
2. The reference shear design value for transverse loads applied parallel to the wide faces of the laminations, F_{vy}, 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 reference shear design value, F_{vy}, 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).
3. For members greater than 15 in. deep, the reference bending design value, F_{bx}, shall be reduced by multiplying by a factor of 0.88.

Tables 6A and 6B Adjustment Factors

Condition Treatment Factor, C_{ct}

Reference design values are based on air dried conditioning. If kiln-drying, steam-conditioning, or boultonizing is used prior to treatment then the reference design values shall be multiplied by the condition treatment factors, C_{ct}.

Condition Treatment Factor, C_{ct}

Air Dried	Kiln Dried	Boulton Drying	Steaming (Normal)	Steaming (Marine)
1.0	0.90	0.95	0.80	0.74

Critical Section Factor, C_{cs}

Reference compression design values parallel to grain, F_c, for round timber piles and poles are based on the strength at the tip of the pile. Reference compression design values parallel to grain, F_c, in Table 6A and Table 6B shall be permitted to be multiplied by the critical section factor. The critical section factor, C_{cs}, shall be determined as follows:

$$C_{cs} = 1.0 + 0.004L_c$$

where:

L_c = length from tip of pile to critical section, ft

The increase for location of critical section shall not exceed 10% for any pile or pole ($C_{cs} \leq 1.10$). The critical section factors, C_{cs}, are independent of tapered column provisions in NDS 3.7.2 and both shall be permitted to be used in design calculations.

Load Sharing Factor (Pile Group Factor), C_{ls}

For piles, reference design values are based on single piles. If multiple piles are connected by concrete caps or equivalent force distributing elements so that the pile group deforms as a single element when subjected to the load effects imposed on the element, reference bending design values, F_b, and reference compression design values parallel to the grain, F_c, shall be permitted to be multiplied by the load sharing factors, C_{ls}.

Load Sharing Factor, C_{ls}

Reference Design Value	Number of Piles in Group	C_{ls}
F_c	2	1.06
	3	1.09
	4 or more	1.11
F_b	2	1.05
	3	1.07
	4 or more	1.08

Size Factor, C_F

For poles and piles with a diameter greater than 13.5", reference bending design values shall be multiplied by the following size factor determined on the basis of an equivalent conventionally loaded square beam of the same cross-sectional area:

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

Table 6A Reference Design Values for Treated Round Timber Piles Graded per ASTM D25

(Tabulated design values are for normal load duration and wet service conditions. See NDS 6.3 for a comprehensive description of design value adjustment factors.)

Species	Design values in pounds per square inch (psi)						Specific Gravity[4]
	Bending	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of elasticity		
	F_b	F_v	$F_{c\perp}$	F_c	E	E_{min}	G
Pacific Coast Douglas Fir[1]	2,050	160	490	1,300	1,700,000	690,000	0.50
Red Pine[2]	1,350	125	270	850	1,300,000	520,000	0.42
Southern Pine (Grouped)[3]	1,950	160	440	1,250	1,500,000	600,000	0.55

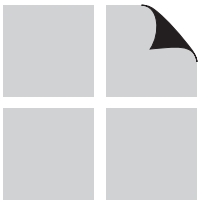
1. Pacific Coast Douglas Fir reference design values apply to this species as defined in ASTM Standard D 1760.
2. Red Pine reference design values apply to Red Pine grown in the United States.
3. Southern Pine reference design values apply to Loblolly, Longleaf, Shortleaf, and Slash Pines.
4. Specific gravity, G, based on weight and volume when oven-dry.

Table 6B Reference Design Values for Round Timber Construction Poles Graded per ASTM D3200

(Tabulated design values are for normal load duration and wet service conditions. See NDS 6.3 for a comprehensive description of design value adjustment factors.)

Species	Design values in pounds per square inch (psi)						Specific Gravity[4]
	Bending	Shear parallel to grain	Compression perpendicular to grain	Compression parallel to grain	Modulus of elasticity		
	F_b	F_v	$F_{c\perp}$	F_c	E	E_{min}	G
Pacific Coast Douglas Fir[1]	2,050	160	490	1,300	1,700,000	690,000	0.50
Lodgepole Pine	1,275	125	265	825	1,100,000	430,000	0.42
Ponderosa Pine	1,200	175	295	775	1,000,000	400,000	0.43
Red Pine[2]	1,350	125	270	850	1,300,000	520,000	0.42
Southern Pine (Grouped)[3]	1,950	160	440	1,250	1,500,000	600,000	0.55
Western Hemlock	1,550	165	275	1,050	1,300,000	560,000	0.47
Western Larch	1,900	170	405	1,250	1,500,000	660,000	0.49
Western Red Cedar	1,250	140	260	875	1,000,000	360,000	0.34

1. Pacific Coast Douglas Fir reference design values apply to this species as defined in ASTM Standard D 1760.
2. Red Pine reference design values apply to Red Pine grown in the United States.
3. Southern Pine reference design values apply to Loblolly, Longleaf, Shortleaf, and Slash Pines.
4. Specific gravity, G, based on weight and volume when oven-dry.



American Wood Council

AWC Mission Statement

To increase the use of wood by assuring the broad regulatory acceptance of wood products, developing design tools and guidelines for wood construction, and influencing the development of public policies affecting the use and manufacture of wood products.

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