Changes to the *2005 NDS Supplement – Design Values for Wood Construction*

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Introduction

An integral part of the *National Design Specification® (NDS®) for Wood Construction* is the *NDS Supplement – Design Values for Wood Construction*. The *2005 NDS Supplement* has been updated to include the latest design values for visually graded lumber and timber, mechanically graded lumber, and glued laminated timber. An overview of those changes is presented here.

Modulus of Elasticity for Beam and Column Stability

A notable change to all design values tables in the *NDS Supplement* is the addition of reference modulus of elasticity for beam and column stability, E_{min}. The *2005 NDS* utilizes E_{min}, which represents a 5 percent lower exclusion shear-free E value so that design value adjustments are not part of the basic design equation for beam and column stability. Applicable adjustments to E_{min} are used to establish the appropriate adjusted modulus of elasticity for beam and column stability, E_{min}', for either ASD or LRFD. Tables 1, 3, and 5A show the additional E_{min} column for visually graded dimension lumber, visually graded timbers, and structural glued laminated timber, respectively. Similar values are included in tables for other materials as well.

Visually Graded Dimension Lumber

Four new species have been added to the *2005 NDS Supplement* for visually graded dimension lumber. **Table 1** outlines four new species: Alaska Cedar, Alaska Hemlock, Alaska Yellow Cedar, and Baldcypress. Alaska Cedar grows in Alaska and the Western states. Alaska Yellow Cedar lumber is manufactured from timber grown only in Alaska.

Mechanically Graded Dimension Lumber

New design values have been added for mechanically graded dimension lumber. Specifically, footnote 2 of Table 4C in the *NDS Supplement* provides specific gravity, shear parallel to grain, and compression perpendicular to grain design values for machine stress rated (MSR) and mechanically evaluated lumber (MEL). **Table 2** provides an overview of the new design values for MSR and MEL lumber.

As with visually graded lumber and timbers, modulus of elasticity for beam and column stability, E_{min}, design values have been added to Table 4C for MSR and MEL lumber.

Visually Graded Timbers

Two new species have been added to the *2005 NDS Supplement* for visually graded timbers. **Table 3** outlines the two new species: Alaska Cedar and Baldcypress.

Non-North American Species

Several new species have been added to *Table 4F – Reference Design Values for Non-North American Visually Graded Dimension Lumber*. **Table 4** summarizes the new Non-North American species.

Structural Glued Laminated Timber

Several changes have been made to structural glued laminated timber design values in the *2005 NDS Supplement*. As with dimension lumber and timber tables, modulus of elasticity for beam and column stability, E_{min}, design values have been added for glued laminated timber.

Species groups for split ring and shear plate connectors were removed from Tables 5A–5D. In some cases, these groups did not correspond to species groups assigned according to *NDS* Table 12A. A review of the data used to establish connector species groups indicated that values in Table 12A are appropriate. Specific gravity, G, of the wood located on the face receiving the connector should be used with *NDS* Table 12A for assignment of species group. This change is consistent with current recommendations of the American Institute of Timber Construction (AITC) and APA–The Engineered Wood Association.

Table 1. New Design Values Added to Table 4A Reference Design Values for Visually Graded Dimension Lumber (2 in. to 4 in. thick) of the *2005 NDS Supplement – Design Values for Wood Construction*.

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending F_b	Tension parallel to grain F_t	Shear parallel to grain F_v	Compression perpendicular to grain $F_{c\perp}$	Compression parallel to grain F_c	Modulus of Elasticity E	Modulus of Elasticity E_{min}	
Alaska Cedar									
Select Structural		1,150	625	165	525	1,000	1,400,000	510,000	
No. 1		975	525	165	525	900	1,300,000	470,000	
No. 2	2″ & wider	800	425	165	525	750	1,200,000	440,000	
No. 3		450	250	165	525	425	1,100,000	400,000	WCLIB
Stud	2″ & wider	625	350	165	525	475	1,100,000	400,000	
Construction		900	500	165	525	950	1,200,000	440,000	
Standard	2″ to 4″ wide	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		1,300	825	185	440	1,200	1,700,000	620,000	
No. 1		900	550	185	440	1,100	1,600,000	580,000	
No. 2	2″ & wider	825	475	185	440	1,050	1,500,000	550,000	
No. 3		475	275	185	440	600	1,400,000	510,000	WWPA
Stud	2″ & wider	650	375	185	440	650	1,400,000	510,000	
Construction		950	550	185	440	1,250	1,400,000	510,000	
Standard	2″ to 4″ wide	525	300	185	440	1,050	1,300,000	470,000	
Utility		250	150	185	440	700	1,200,000	440,000	
Alaska Yellow Cedar									
Select Structural		1,350	800	225	510	1,200	1,500,000	550,000	
No. 1		900	525	225	510	1,050	1,400,000	510,000	
No. 2	2″ & wider	800	450	225	510	1,000	1,300,000	470,000	
No. 3		475	250	225	510	575	1,200,000	440,000	WWPA
Stud	2″ & wider	625	350	225	510	625	1,200,000	440,000	WCLIB
Construction		925	500	225	510	1,250	1,300,000	470,000	
Standard	2″ to 4″ wide	500	275	225	510	1,050	1,100,000	400,000	
Utility		250	125	225	510	675	1,100,000	400,000	
Baldcypress									
Select Structural		1,200	650	160	615	1,200	1,400,000	510,000	
No. 1		1,000	550	160	615	1,050	1,400,000	510,000	
No.2	2″ & wider	825	450	160	615	900	1,300,000	470,000	
No. 3		475	250	160	615	525	1,200,000	440,000	SPIB
Stud	2″ & wider	650	350	160	615	575	1,200,000	440,000	
Construction		925	500	160	615	1,100	1,200,000	440,000	
Standard	2″ to 4″ wide	525	275	160	615	925	1,100,000	400,000	
Utility		250	125	160	615	600	1,000,000	370,000	

Table 2. New Design Values Added to Footnote 2 of Table 4C Reference Design Values for Mechanically Graded Dimension Lumber of the *2005 NDS Supplement – Design Values for Wood Construction.*

Species	Modulus of Elasticity E ($\times 10^6$) (psi)	Specific Gravity G	Shear Parallel to Grain F_v (psi)	Compression Perpendicular to Grain $F_{c\perp}$ (psi)	Grading Rules Agency
Douglas Fir-Larch (N)	1.0 and higher	0.49	180	625	NLGA
	1.2 to 1.9	0.49	180	625	
	2.0 to 2.2	0.53	180	715	
	2.3 and higher	0.57	190	715	

Table 3. New Design Values Added to Table 4D Reference Design Values for Visually Graded Dimension Lumber (5″ by 5″ and larger) of the *2005 NDS Supplement – Design Values for Wood Construction*.

Species and commercial grade	Size classification	Design values in pounds per square inch (psi)							Grading Rules Agency
		Bending F_b	Tension parallel to grain F_t	Shear parallel to grain F_v	Compression perpendicular to grain $F_{c\perp}$	Compression parallel to grain F_c	Modulus of Elasticity E	Modulus of Elasticity E_{min}	
Alaska Cedar									
Select Structural	Beams and Stringers	1400	675	155	525	925	1,200,000	440,000	WCLIB
No. 1		1150	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	1300	700	155	525	975	1,200,000	440,000	
No. 1		1050	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″ × 5″ & larger	1150	750	200	615	1,050	1,300,000	470,000	SPIB
No. 1		1000	675	200	615	925	1,300,000	470,000	
No. 2		625	425	175	615	600	1,000,000	370,000	

Table 4. New Non-North American Species Added to Table 4F in the *2005 NDS Supplement – Design Values for Wood Construction*.

Species	Grading Rules Agency
Montane pine – South Africa	WCLIB
Norway Spruce – Romania and the Ukraine	WCLIB
Silver fir (*Abies alba*) – Germany, NE France, and Switzerland	WCLIB
Southern Pine – Misiones Argentina	SPIB
Southern Pine – Misiones Argentina, free of heart center and medium grain density	SPIB

Table 5. Shear parallel to grain design value (F_v) comparison for Southern Pine and Douglas Fir glued laminated timber from 1991 to present, psi.

	1991 NDS Supplement	*1997 NDS Supplement*	*2001 NDS Supplement*	*2005 NDS Supplement*
Douglas Fir				
Prismatic Members, F_v	165	190	240	265
Notched/Connections/Cyclic, F_v	165	190	192 (=240 × 0.8)	191 (=265 × 0.72)
Radial Tension (Reinforced), F_{rt}	55 (=165/3)	63 (=190/3)	56 (=240 × 0.7 / 3)	63 (=191/3)
Southern Pine				
Prismatic Members, F_v	200	240	270	300
Notched/Connections/Cyclic, F_v	200	240	216 (=270 × 0.8)	216 (=300 × 0.72)
Radial Tension, F_{rt}	67 (=200/3)	80 (=240/3)	63 (=270 × 0.7 / 3)	72 (=216/3)

There were specific changes to Tables 5A, 5A-Expanded, and 5B. An overview is provided below and is organized by *NDS Supplement* table number.

Table 5A Design Values for Structural Glued Laminated Softwood Timber (Members stressed primarily in bending) and Table 5A Expanded – Design Values for Structural Glued Laminated Timber (Members stressed primarily in bending).

Table 5A of the NDS Supplement is included for reference. Design values for tension parallel to grain, F_t, compression parallel to grain, F_c, and specific gravity, G, are revised for the 16F stress class. The *2001 NDS Supplement* showed different values for this stress class in Table 5A vs. 5A-Expanded. Analysis indicated that the values in Table 5A-Expanded were correct, so Table 5A was updated accordingly.

Shear parallel to grain (horizontal shear) design values have increased for prismatic members, and adjustment factors in accordance with Footnote d have been revised. Horizontal shear values in the *2001 NDS Supplement* were based on full-scale tests of laminated beams, which were reduced by 10 percent based on judgments made at that time. Shear values for non-prismatic members were those derived according to *ASTM D3737* from tests of small shear-block specimens. Since that time, the structural glued laminated timber industry has revised its recommendations and has elected to publish test-based shear values for prismatic members, removing the 10 percent reduction. This change is reflected in the *2005 NDS Supplement* consistent with recommendations of AITC and APA. Footnote d adjustment fac-

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														
	Tension Zone Stresssed in Tension (Positive Bending)	Compression Zone Stressed in Tension (Negative Bending)	Compression Perpendicular to Grain	Shear Parallel to Grain (Horizontal)	Modulus of Elasticity	Modulus of Elasticity for Beam and Column Stability	Extreme Fiber in Bending	Compression Perpendicular to Grain	Shear Parallel to Grain (Horizontal)	Modulus of Elasticity	Modulus of Elasticity for Beam and Column Stability	Tension Parallel to Grain	Compression Parallel to Grain	Modulus of Elasticity	Specific Gravity for Fastener Design
Stress Class	F_{bx}^{+} (psi)	F_{bx}^{-} [a] (psi)	$F_{c\perp x}$ (psi)	F_{vx} [d] (psi)	E_x (10^6 psi)	$E_{x\,min}$ (10^6 psi)	F_{by} (psi)	$F_{c\perp x}$ (psi)	F_{vy} [d,e] (psi)	E_y (10^6 psi)	$E_{y\,min}$ (10^6 psi)	F_t (psi)	F_c (psi)	E_{axial} (10^6 psi)	G
16F-1.3E	1600	925	315	195	1.3	0.67	800	315	170	1.1	0.57	675	925	1.2	0.42
20F-1.5E	2000	1100	425	210[f]	1.5	0.78	800	315	185	1.2	0.62	725	925	1.3	0.42
24F-1.7E	2400	1450	500	210[f]	1.7	0.88	1050	315	185	1.3	0.67	775	1000	1.4	0.72
24F-1.8E	2400	1450[b]	650	265[c]	1.8	0.93	1450	560	230[c]	1.6	0.83	1100	1600	1.7	050[j]
26F-1.9E[g]	2600	1950	650	265[c]	1.9	0.98	1600	560	230[c]	1.6	0.83	1150	1600	1.7	0.50[j]
28F-2.1E SP[g]	2800	2300	740	300	2.1[i]	1.09[i]	1600	650	260	1.7	0.88	1250	1750	1.7	0.55
30F-2.1E SP[g,h]	3000	2400	740	300	2.1[i]	1.09[i]	1750	650	260	1.7	0.88	1250	1750	1.7	0.55

[a] For balanced layups, F_{bx}^{-} shall be equal to F_{bx}^{+} for the stress class. Designer shall specify when balanced layup is required.

[b] Negative bending stress, 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 stresses are required.

[c] For structural glued laminated timber of Southern Pine, the basic shear design values, F_{vx} and F_{vy}, are permitted to be increased to 300 psi, and 260 psi, respectively.

[d] The design value for shear, F_{vx} and F_{vy}, shall be decreased by multiplying by a factor of 0.72 for non-prismatic members, notched members, and for all members subject to impact or cyclic loading. The reduced design value shall be used for design of members at connections that transfer shear by mechanical fasteners (NDS 3.4.3.3). The reduced design value shall also be used for determination of design values for radial tension (NDS 5.2.2).

[e] Design values are for timbers with laminations made from a single piece of lumber across the width or multiple pieces that have been edge bonded. For timbers manufactured from multiple piece laminations (across width) that are not edge bonded, value shall be multiplied by 0.4 for members with 5, 7, or 9 laminations or by 0.5 for all other members. This reduction shall be cumulative with the adjustment in footnote (d).

[f] Certain Southern Pine combinations may contain lumber with wane. If lumber with wane is used, the design value for shear parallel to grain, F_{vx}, shall be multiplied by 0.67 if wane is allowed on both sides. If wane is limited to one side, F_{vx} shall be multiplied by 0.83. This reduction shall be cumulative with the adjustment in footnote (d).

[g] 26F, 28F, and 30F beams are not produced by all manufacturers, therefore, availability may be limited. Contact supplier or manufacturer for details.

[h] 30F combinations are restricted to a maximum 6 in. nominal width.

[i] For 28F and 30F members with more than 15 laminations, $E_x = 2.0$ million psi and $E_{x\,min} = 1.04$ million psi.

[j] For structural glued laminated timber of Southern Pine, specific gravity for fastener design is permitted to be increased to 0.55.

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

tors were revised to keep shear values for non-prismatic members essentially unchanged.

Historically, radial tension design values for structural glued laminated timber were established as one-third of shear parallel to grain design values. In the *1991 NDS*, radial tension values were 67 psi for Southern Pine and 55 psi for Douglas Fir-Larch, respectively. For Douglas Fir-Larch, radial reinforcement designed to carry all induced stresses was required to utilize this value, otherwise the radial tension value was limited to 15 psi–this point was clarified in the *2005 NDS*. Comparing 2005 to *1991 NDS Supplements*, increased shear values for non-prismatic members of Douglas Fir-Larch and Southern Pine have resulted in small increases for radial tension design values in these species. The slightly increased radial stresses are recommended by AITC and APA and are considered appropriate and preferable to multiple adjustment factors as were used in the *2001 NDS*.

Table 5B Design Values for Structural Glued Laminated Softwood Timber (Members stressed primarily in axial tension or compression)

Table 5B of the *NDS Supplement* incorporates the following changes:

- Re-formatting of bending design values for bending about the X-X axis, F_{bx}. If special tension laminations are included, tabulated values may be adjusted according to applicable footnotes.
- New combinations for Southern Pine were added with extra information regarding slope of grain differences.
- Shear value columns were consolidated for bending about the Y-Y axis, F_{vy}, and shear values were updated consistent with Table 5A discussion above.

Conclusion

The *2005 NDS Supplement* has been updated to include the latest design values for visually graded lumber and timber, mechanically graded lumber, and structural glued laminated timber. An overview of those changes has been presented. The most notable change to all design value tables in the *NDS Supplement* is the addition of minimum modulus of elasticity values for beam and column stability, E_{min}, design. The change to shear design values for prismatic glued laminated timber members is another significant modification.

The *2005 NDS Supplement* is part of the 2005 AF&PA Wood Design Package which will be published in the first quarter of 2005. For more information, visit AF&PA's American Wood Council website at www.awc.org.

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