New Provisions in the *National Design Specification®* (*NDS®*) for Wood Construction

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Introduction

The 1997 edition of the *National Design Specification (NDS) for Wood Construction* has been published by the American Forest & Paper Association's (AF&PA) American Wood Council (AWC). This culminates 5 years of development by the wood products industry to provide state-of-the-art information for wood design, improve the design process, and more accurately reflect the field performance of wood members and connections. This latest edition of the *NDS* was approved as an American National Standard on August 7, 1997, and designated *ANSI/AF&PA NDS-1997*. The *NDS Supplement Design Values for Wood Construction*, an integral part of the *NDS*, has also been updated to provide the latest design values for lumber and glued laminated timber. Changes to the *NDS* include:

- new provisions for timber rivets;
- new provisions for wood-to-concrete connections;
- new provisions for designing notches on the compression face of a bending member;
- new incising adjustment factors;
- simplified wet service factors for connectors;
- new combined lateral/withdrawal equation for nails;
- modification of nail clinching provisions;
- clarification of built-up column provisions;
- revised upper limit on load duration factors for pressure-preservative and fire retardant-treated wood;
- update of lumber and glued laminated timber design values (*NDS Supplement*); and
- permissive language replaced with mandatory language.

Timber Rivets

Timber rivet connections have been used in Canada for decades. New design criteria introduced in Chapter 13 of the *NDS* apply to joints with steel side plates for glued laminated timber made from either Southern Pine or western species. Originally called the "glulam rivet," the term "timber rivet" was chosen to accommodate future application to sawn lumber as well.

The high-strength nails used to attach steel side plates to wood members are rectangular in cross-section (Fig. 1) and must have a minimum ultimate tensile strength of 145,000 psi. Steel side plates must conform to *ASTM A36* (ASTM 1996) and be at least 1/8-inch thick. Timber rivet connections are evaluated for both wood capacity and rivet capacity. Minimum end and edge distance and spacing are prescribed, as well as fabrication sequence. Connection capacities as high as 129,000 pounds can be developed using timber rivets. Joint configurations can be developed to allow parallel-to-grain loads, perpendicular-to-grain loads, or loads at an angle to the grain (Fig. 2).

Wood-to-Concrete Connections

New provisions have been incorporated for wood-to-concrete connections. In previous editions of the *NDS*, a designer assumed a main member thickness (concrete) equal to twice the thickness of the side member (wood), with the same dowel-bearing strength as that of the wood member. In section 8.2.3 of the 1997 *NDS*, connection values may be calculated specifically using dowel-bearing strengths for the wood member and the concrete. Design values are tabulated assuming a concrete dowel-bearing strength of 6,000 psi for concrete with 6 inches and greater embedment depth. Wood member sizes of 1.5, 2.5, and 3.5 inches are tabulated. This will increase bolt design values (Z) by up to 30 percent for some common wood-to-concrete connections (Table 1).

Notches and Taper Cuts

New provisions for compression side notches and taper cuts at the ends of bending members have been added to section 3.4.4.5 of the 1997 *NDS*. These provisions are based on similar provisions included in AITC's *Timber Construc-*

tion Manual (AITC 1994) and apply to both glued laminated timber and dimension lumber. The new provisions recognize that a compression side notch is less severe than a tension side notch, and that a taper cut on the compression side is less severe than a notch on the compression side.

Adjustment Factors for Incised Lumber

New design value adjustment factors for timber and lumber that is incised to increase penetration of preservatives have been added to section 2.3.11 of the *NDS*. These provisions apply to structural sawn lumber with incisions made parallel-to-grain that have a maximum depth of 3/4-inch, a maximum length of 3/8-inch, and a maximum density of 357 incisions per square foot. Reductions are 5 percent for modulus of elasticity and 15 percent for bending, tension, and compression parallel-to-grain design values.

Wet Service Factors for Connectors

Table 7.3.3 of the 1997 *NDS*, which outlines wet service factors for connections, has been simplified from 23 to 15 cases. The technical committees of AF&PA and ANSI determined that the degree of accuracy being portrayed by showing, for example, a 0.75 factor for wood screws "exposed" to moisture in service versus a 0.67 factor for wood screws that are "wet" in service, was too precise. These factors, therefore, were combined to 0.7 for any in-service application where wood moisture content exceeds 19 percent. This change was made to all connectors included in the table. Factors for timber rivets were added to this table as well.

Combined Lateral/Withdrawal Equation for Nails

A new equation for calculating combined lateral/withdrawal design values for nails and spikes was developed consistent with those added to the 1991 *NDS* for wood screws and lag screws. Section 12.3.8 of the 1997 *NDS* incorporates this new provision.

Nail Clinching

Modification of nail clinching provisions to allow only a 1.75 increase instead of 2.0 for double shear nailed connections is included in section 12.3.3 of the latest edition of the *NDS*. Re-evaluation of the research used to develop the original provisions indicated that the increased capacity for clinched nails depended on the quality of the clinch (how far the nail was bent relative to 90°) and the direction of the clinch relative to grain orientation. The technical committees of AF&PA and ANSI determined that the 1.75 factor better reflected test data.

Built-Up Columns

Provisions for built-up columns in section 15.3 of the 1997 *NDS* have been updated to clarify the application of column stability coefficients for nailed and bolted built-up columns. Column stability coefficients, K_f, of 0.6 and 0.75 are applicable to the potential buckling direction perpen-

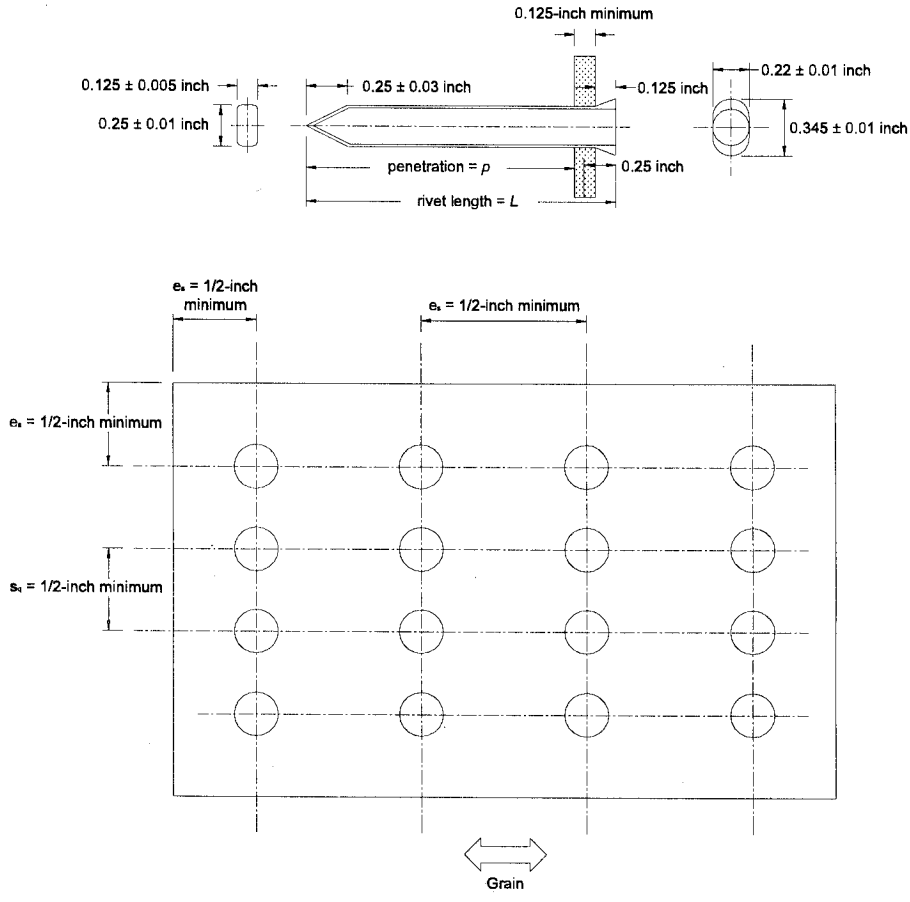

Figure 1.—Timber rivet and steel side plate (AF&PA 1997).

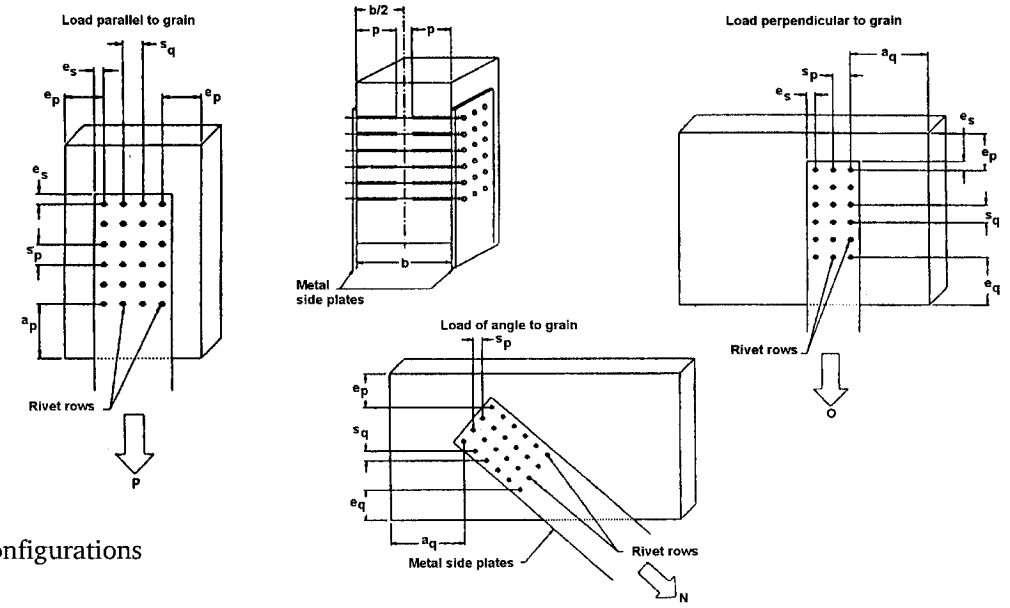

Figure 2.—Timber rivet joint configurations (AF&PA 1997).

Table 1.—Increases in bolt design values (Z) for single shear (two member) wood-to-concrete connections made with Southern Pine (G=0.55)[a].

			1997 NDS		1991 NDS		Ratio 1997/1991	
t_m	t_s	D	$Z_{\|\|}$	$Z_\perp$	$Z_{\|\|}$	$Z_\perp$	$Z_{\|\|}$	$Z_\perp$
- - - -	(in.)	- - - -						
6+	1.5	0.50	660	400	660	360	1.00	1.1
		0.75	1,270	660	1,270	500	1.00	1.3
		1.00	2,140	760	1,740	580	1.23	1.3

[a] Excerpted from Table 8.2E of the 1997 *NDS*; t_m equals embedment depth in concrete, t_s equals thickness of wood member, D equals bolt diameter.

dicular to the weak axis of individual members for nailed and bolted built-up columns, respectively. A column stability coefficient of 1.0 is used for the potential buckling direction parallel to the strong axis of individual members.

Load Duration Factors for Treated Lumber

Recent research at the USDA Forest Products Laboratory, Madison, Wisconsin, indicated that the load duration factor for pressure-preservative treated wood should be limited to 1.6 or less. As a result, footnote 2 of *NDS* Table 2.3.2 now states "Load duration factors greater than 1.6 shall not apply to structural members pressure-treated with waterborne preservatives, or fire retardant chemicals. The impact load duration factor shall not apply to connections." Frequently used load duration factors for wood design are presented in Table 2.3.2 of the *NDS*.

Design Values for Lumber and Glued Laminated Timber

Design values for lumber and glued laminated timber have been revised to reflect current data from the wood industry. Changes, for the most part, are minor and include rounding increases; new machine stress-rated (MSR) lumber and mechanically evaluated lumber (MEL) grades; higher specific gravity (G), horizontal shear (F_v), and compression perpendicular-to-grain ($F_{c\perp}$) design values for certain MSR and MEL grades; and new glued laminated timber combinations and design values.

New grades of MSR lumber include 1700f-1.6E, 1750f-2.0E, 2250f-1.7E, and 2250f-1.8E. MSR grades that were eliminated include 3150f-2.5E and 3300f-2.6E, and all 6-inch and wider sizes. New grades of MEL include M-5 through M-9, M-28, and M-29. Additionally, design values for certain species and grades of MSR and MEL have increased (Table 2).

New Southern Pine glued laminated timber combinations include 26F visual rated, and 28F and 30F E-rated. Also, compression perpendicular-to-grain values for most Southern Pine glued laminated timber combinations have increased from 650 psi to 740 psi. Horizontal shear values for certain Southern Pine glued laminated timber combinations have increased from 200 psi to 240 psi, and those for Douglas Fir-Larch from 165 psi to 190 psi.

Mandatory Language

Of the 130 changes balloted to the ANSI committee for the *NDS*, approximately two-thirds requested modification of *NDS* language to make the document more suitable for building code enforcement. Some building code policies require mandatory language rather than permissive statements to ensure enforceability. Therefore, terms like "may" were changed to "shall" in various sections of the *NDS* to accommodate this requirement. Much of the background information contained in the *NDS* was moved to the *NDS Commentary*.

Table 2.—Increases in design values for MEL and MSR lumber.

Species	Grade	G		$F_{c\perp}$		F_v	
		1997	1991	1997	1991	1997	1991
				(psi)			
Spruce-Pine-Fir	$E \geq 2{,}000{,}000$	0.50	0.42	615	425	no change	
Southern Pine	$E \geq 1{,}900{,}000$	0.57	0.55	805	565	100	90
Engelmann Spruce-Lodgepole Pine	$F_b \geq 1650$f	0.46	0.38	no change		no change	

NDS Commentary

The *Commentary* to the *NDS* is being updated to reflect changes in the 1997 edition. An addendum to the *NDS Commentary* should be available in 1998.

WoodWorks® Software

WoodWorks Sizer has been updated to incorporate the latest provisions of the 1997 *NDS*. New features of *Sizer 97* include:

- design for fire resistance in accordance with AWC's *Design of Fire-Resistive Exposed Wood Members—DCA No. 2*;
- ability to design multi-span joists;
- viewing results anywhere along a member length;
- printout of materials list;
- walls supported by joist areas away from bearing supports; and
- output for reactions on foundations.

Sizer is available on CD-ROM as part of the *WoodWorks Design Office 97* package. Additional features of *WoodWorks* include:

- *Sizer*—designs beams, columns, and beam-columns;
- *Connections*—designs bolted and nailed connections;
- *Shearwalls*—designs traditional and perforated shearwalls for high wind applications;
- 1997 *NDS* in Adobe® Acrobat® PDF format—electronic version of the *NDS;*
- *Code Conforming Wood Design*—determines allowable heights and areas for wood structures; and
- Adobe Acrobat Reader—reads PDF files (for the electronic version of the *NDS*).

The *NDS, NDS Supplement Design Values for Wood Construction,* and *NDS Commentary* are available from AWC and can be ordered by calling 1-800-890-7732. *WoodWorks Design Office 97* can be ordered by calling 1-800-844-1275. A demonstration copy of *WoodWorks* software can be downloaded from AWC's website at www.awc.org. Contact the AWC Technical Inquiry Clearinghouse at 1-800-AWC-AFPA or email awcinfo@afandpa.org for more information.

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News

Leading Engineering Societies Worldwide Develop First International Conference for Structural Engineers

Six worldwide structural engineering related organizations have come together to develop the first global conference for structural engineers. The Structural Engineers World Congress (SEWC) will take place July 19-23, 1998, at the San Francisco Marriott in the heart of San Francisco's business district. SEWC will feature a comprehensive technical program, addressing every major structural issue from seismic design to state-of-the-art materials.

SEWC also boasts the largest number of sessions devoted to the business and practice of structural engineering ever presented at one conference—30 sessions and more than 100 papers. The congress will also feature the largest exhibition of suppliers of structural materials and systems and computer modeling programs ever organized for practicing structural engineers The conference is designed to be one of the most user-friendly ever, featuring a take-home package that includes a CD-