AF&PA®

AMERICAN FOREST & PAPER ASSOCIATION
American Wood Council
Engineered and Traditional Wood Products

March 2002

2002 ADDENDUM
to the
1997 NDS and PRIOR EDITIONS

The 2001 Edition of the *National Design Specification®(NDS®) for Wood Construction* contains editorially clarified provisions for checking stresses in members at connections. The following requirements, included in the *2001 NDS*, are also applicable to all prior editions of the *NDS*:

Stresses in Members at Connections - Structural members shall be checked for load carrying capacity at connections in accordance with all applicable provisions of the *NDS*. Local stresses in connections using multiple fasteners shall be checked in accordance with principles of engineering mechanics.

One method for determining these stresses is provided in the attached Appendix E from the *2001 NDS*. All referenced sections and design values used in sample solutions of this Addendum are based on information in the *2001 NDS*.

1111 Nineteenth Street, NW, Suite 800 - Washington, DC 20036 - 202 463-2766 - Fax: 202 463-2791 - www.awc.org

Appendix E (Non-mandatory) Local Stresses in Fastener Groups

E.1 General

Where a fastener group is composed of closely-spaced fasteners loaded parallel to grain, the capacity of the fastener group may be limited by wood failure at the net section or tear-out around the fasteners caused by local stresses. One method to evaluate member strength for local stresses around fastener groups is outlined in the following procedures.

E.1.1 Tabulated nominal design values for timber rivet connections in Chapter 13 account for local stress effects and do not require further modification by procedures outlined in this Appendix.

E.1.2 The capacity of connections with closely-spaced, large diameter bolts has been shown to be limited by the capacity of the wood surrounding the connection. Connections with groups of smaller diameter fasteners, such as typical nailed connections in wood-frame construction, may not be limited by wood capacity.

E.2 Net Section Tension Capacity

The allowable tension capacity is calculated in accordance with provisions of 3.1.2 and 3.8.1 as follows:

$$Z_{NT}' = F_t' A_{net} \qquad \text{(E.2-1)}$$

where:

Z_{NT}' = allowable tension capacity of net section area

F_t' = allowable tension design value parallel to grain

A_{net} = net section area per 3.1.2

E.3 Row Tear-Out Capacity

The allowable tear-out capacity of a row of fasteners can be estimated as follows:

$$Z_{RT_i}' = n_i \frac{F_v' A_{critical}}{2} \qquad \text{(E.3-1)}$$

where:

Z_{RTi}' = allowable row tear out capacity of row i

F_v' = allowable shear design value parallel to grain

$A_{critical}$ = minimum shear area of any fastener in row i

n_i = number of fasteners in row i

E3.1 Assuming one shear line on each side of bolts in a row (observed in tests of bolted connections), Equation E.3-1 becomes:

$$\begin{aligned} Z_{RT_i}' &= \frac{F_v' t}{2}[n_i S_{critical}](2 \textit{ shear lines}) \\ &= n_i F_v' t S_{critical} \end{aligned} \qquad \text{(E.3-2)}$$

where:

$S_{critical}$ = minimum spacing in row i taken as the lesser of the end distance or the spacing between fasteners in row i

t = thickness of member

The total allowable row tear-out capacity of multiple rows of fasteners can be estimated as:

$$Z_{RT}' = \sum_{i=1}^{n_{row}} Z_{RT_i}' \qquad \text{(E.3-3)}$$

where:

Z_{RT}' = allowable row tear out capacity of multiple rows

n_{row} = number of rows

E.3.2 In Equation E.3-1, it is assumed that the induced shear stress varies from a maximum value of $f_v = F_v'$ to a minimum value of $f_v = 0$ along each shear line between fasteners in a row and that the change in shear stress/strain is linear along each shear line. The resulting triangular stress distribution on each shear line between fasteners in a row establishes an apparent shear stress equal to half of the design shear stress, $F_v'/2$, as shown in Equation E.3-1. This assumption is combined with the critical area concept for evaluating stresses in fastener groups and provides good agreement with results from tests of bolted connections.

E3.3 Use of the minimum shear area of any fastener in a row for calculation of row tear-out capacity is based on the assumption that the smallest shear area between fasteners in a row will limit the capacity of the row of fasteners. Limited verification of this approach is provided from tests of bolted connections.

E.4 Group Tear-Out Capacity

The allowable tear-out capacity of a group of "n" rows of fasteners can be estimated as:

$$Z_{GT}' = \frac{Z_{RT-1}'}{2} + \frac{Z_{RT-n}'}{2} + F_t' A_{group-net} \quad \text{(E.4-1)}$$

where:

Z_{GT}' = allowable group tear-out capacity

Z_{RT-1}' = allowable row tear-out capacity of Row 1 of fasteners bounding the critical group area

Z_{RT-n}' = allowable row tear-out capacity of Row n of fasteners bounding the critical group area

$A_{group-net}$ = critical group net section area between Row 1 and Row n

E.4.1 For groups of fasteners with non-uniform spacing between rows of fasteners various definitions of critical group area should be checked for group tear-out in combination with row tear-out to determine the allowable capacity of the critical section.

E.5 Effects of Fastener Placement

E 5.1 Modification of fastener placement within a fastener group can be used to increase row tear-out and group tear-out capacity limited by local stresses around the fastener group. Increased spacing between fasteners in a row is one way to increase row tear-out capacity. Increased spacing between rows of fasteners is one way to increase group tear-out capacity.

E 5.2 Footnote 2 to Table 11.5.1D limits the spacing between outer rows of fasteners paralleling the member on a single splice plate to 5 inches. This requirement is imposed to limit local stresses resulting from shrinkage of wood members. When special detailing is used to address shrinkage, such as the use of slotted holes, the 5 inch limit can be adjusted.

E.6 Sample Solution of Staggered Bolts

Calculate the net section area tension, row tear-out, and group tear-out allowable design capacities for the double-shear bolted connection in Figure E1.

Main Member:
Combination 3 Douglas fir 3-1/8 x 12 glued laminated timber member
F_t' = 1450 psi
F_v' = 240 psi
Main member thickness, t_m: 3.125 inches
Main member width, w: 12 inches

Side Member:
A36 steel plates on each side
Side plate thickness, t_s: 0.25 inches

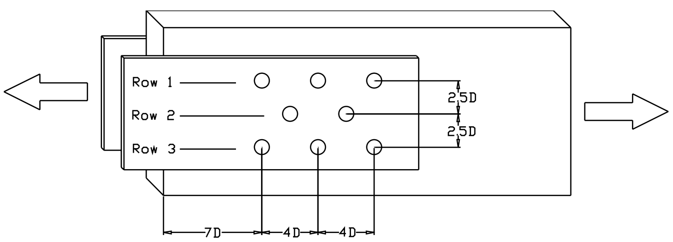
Connection Details:
Bolt diameter, D: 1 inch
Bolt hole diameter, D_h: 1.0625 inches

Allowable bolt design value, $Z_{||}'$: 4380 lbs. (see NDS Table 11I. For this trial design, the group action factor, C_g, is taken as 1.0).
Spacing between rows: S_{row} = 2.5D

Allowable Connection Capacity, $nZ_{||}'$:

$nZ_{||}'$ = (8 bolts)(4380 lbs.) = 35,040 lbs.

Figure E1 Staggered Rows of Bolts



Allowable Net Section Area Tension Capacity, Z_{NT}':

$$Z_{NT}' = F_t' t[w - n_{row} D_h]$$

Z_{NT}' = (1450 psi)(3.125")[12"-3(1.0625")] = 39,930 lbs.

Allowable Row Tear-Out Capacity, Z_{RT}':

$$Z_{RT_i}' = n_i F_v' t S_{critical}$$

Z_{RT-1}' = 3(240 psi)(3.125")(4") = 9,000 lbs.

$Z_{RT\text{-}2}' = 2(240 \text{ psi})(3.125")(") = 6{,}000 \text{ lbs.}$

$Z_{RT\text{-}3}' = 3(240 \text{ psi})(3.125")(4") = 9{,}000 \text{ lbs.}$

$$Z_{RT}' = \sum_{i=1}^{n_{row}} Z_{RT_i}' = 9{,}000 + 6{,}000 + 9{,}000 = 24{,}000 \text{ lbs.}$$

Allowable Group Tear-Out Capacity, Z_{GT}':

$$Z_{GT}' = \frac{Z_{RT-1}'}{2} + \frac{Z_{RT-3}'}{2} + F_t' t[(n_{row} - 1)(S_{row} - D_h)]$$

$$\begin{aligned} Z_{GT}' = {} & (9{,}000 \text{ lbs.})/2 + (9{,}000 \text{ lbs.})/2 + \\ & (1450 \text{ psi})(3.125")[(3\text{-}1)(2.5"\text{-}1.0625")] \\ = {} & 22{,}030 \text{ lbs.} \end{aligned}$$

In this sample calculation, the connection capacity is limited to 22,030 pounds by group tear-out, Z_{GT}'.

E.7 Sample Solution of Row of Bolts

Calculate the net section area tension and row tear-out allowable design capacities for the single-shear single-row bolted connection represented in Figure E2.

Main and Side Members:
#2 grade Hem-Fir 2x4 lumber
$F_t' = 788$ psi
$F_v' = 145$ psi
Main member thickness, t_m: 3.5 inches
Side member thickness, t_s: 1.5 inches
Main and side member width, w: 3.5 inches

Connection Details:
Bolt diameter, D: 1/2 inch
Bolt hole diameter, D_h: 0.5625 inches
Allowable bolt design value, $Z_{\parallel}'$: 550 lbs. (See NDS Table 11A. For this trial design, the group action factor, C_g, is taken as 1.0).

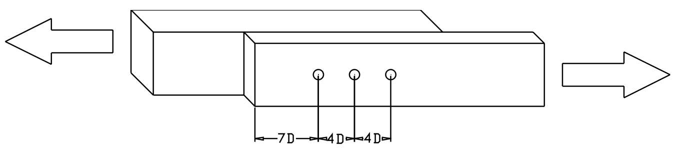
Allowable Connection Capacity, $nZ_{\parallel}'$:

$nZ_{\parallel}' = (3 \text{ bolts})(550 \text{ lbs.}) = 1{,}650 \text{ lbs.}$

Allowable Net Section Area Tension Capacity, Z_{NT}':

$$Z_{NT}' = F_t' t[w - n_{row} D_h]$$

Figure E2 Single Row of Bolts



$Z_{NT}' = (788 \text{ psi})(1.5")[3.5"\text{-}1(0.5625")] = 3{,}470 \text{ lbs.}$

Allowable Row Tear-Out Capacity, Z_{RT}':

$$Z_{RT_i}' = n_i F_v' t S_{critical}$$

$Z_{RT1}' = 3(145 \text{ psi})(1.5")(2") = 1{,}310 \text{ lbs.}$

In this sample calculation, the connection capacity is limited to 1,310 pounds by row tear-out, Z_{RT}'.

E.8 Sample Solution of Row of Split Rings

Calculate the net section area tension and row tear-out allowable design capacities for the single-shear single-row split ring connection represented in Figure E3.

Main and Side Members:
#2 grade Southern Pine 2x4 lumber
$F_t' = 825$ psi
$F_v' = 175$ psi
Main member thickness, t_{m}: 1.5 inches
Side member thickness, t_s: 1.5 inches
Main and side member width, w: 3.5 inches

Connection Details:
Split ring diameter, D: 2.5 inch (see Appendix K for connector dimensions)
Allowable split ring design value, P′: 2730 lbs. (see NDS Table 12.2A. For this trial design, the group action factor, C_g, is taken as 1.0).

Allowable Connection Capacity, nP′:

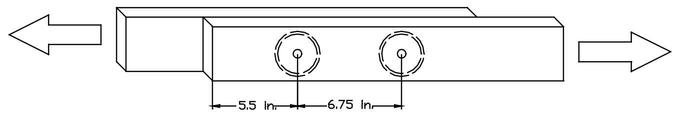
$$nP' = (2 \text{ split rings})(2730 \text{ lbs.}) = 5{,}460 \text{ lbs.}$$

Allowable Net Section Area Tension Capacity, Z_{NT}':

$$Z_{NT}' = F_t' A_{net}$$

$$\begin{aligned} Z_{NT}' &= (825 \text{ psi})[5.25 \text{ in.}^2 - 1.5\text{"}\,(0.5625\text{"}) - 1.1 \text{ in.}^2] \\ &= 2{,}728 \text{ lbs.} \end{aligned}$$

Figure E3 Single Row of Split Ring Connectors



Allowable Row Tear-Out Capacity, Z_{RT}':

$$Z_{RT_i}' = n_i \frac{F_v' A_{critical}}{2}$$

$$\begin{aligned} Z_{RT1}' &= [(2 \text{ connectors})(175 \text{ psi})/2\,] \times [(2 \text{ shear lines})(0.375\text{"})(5.5\text{"}) + (1 \text{ shear line})(17.6 \text{ in.}^2)] \\ &= 3{,}802 \text{ lbs.} \end{aligned}$$

In this sample calculation, the connection capacity is limited to 2,728 pounds by net section area tension capacity, Z_{NT}'.

AF&PA

AMERICAN FOREST & PAPER ASSOCIATION
American Wood Council
Engineered and Traditional Wood Products

2000 Errata/Addendum
to
1997 Edition of

DESIGN VALUES FOR WOOD CONSTRUCTION, a Supplement to the NATIONAL DESIGN SPECIFICATION® (NDS®) FOR WOOD CONSTRUCTION

Page **Revision**

38-42 Revise Table 4D Design values as follows:

Species and Commercial Grade	Size Classification	Design values in pounds per square inch (psi)			Grading Rules Agency
		Bending F_b	Tension F_t	Compression Parallel to Grain F_c	
DOUGLAS FIR-LARCH					
Dense Select Structural	Beams and Stringers	~~1850~~ 1900	1100	1300	WWPA
Dense No. 2 No. 2	Posts and Timbers	~~800~~ 850 ~~700~~ 750	550 475	~~550~~ 825 ~~475~~ 700	WWPA
DOUGLAS FIR-SOUTH					
No. 2	Beams and Stringers	825	425	~~525~~ 550	WWPA
Select Structural No. 2	Posts and Timbers	~~1400~~ 1450 ~~650~~ 675	950 ~~400~~ 450	1050 ~~425~~ 650	WWPA
HEM-FIR					
Select Structural No. 1 No. 2	Beams and Stringers	~~1250~~ 1300 1050 675	~~725~~ 750 525 ~~325~~ 350	925 ~~775~~ 750 ~~475~~ 500	WWPA
No. 1 No. 2	Posts and Timbers	~~950~~ 975 ~~525~~ 575	650 ~~350~~ 375	850 ~~375~~ 575	WWPA
WESTERN CEDARS					
Select Structural	Beams and Stringers	1150	~~700~~ 675	875	WWPA
No. 2	Posts and Timbers	~~500~~ 550	350	~~375~~ 550	WWPA

Future Updates will be available at www.awc.org

Shear Design Values for Lumber Shear design values for lumber have recently been revised and approved by the American Lumber Standard Committee, in accordance with changes to ASTM Standard D 245, *Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber*. These new lumber shear design values are higher than earlier assigned values. To obtain more information on new lumber shear design values, contact any of the following agencies:

Canadian Wood CouncilSouthern Pine Inspection BureauWest Coast Lumber Inspection BureauWestern Wood Products Association

Design provisions, including requirements for shear design of lumber, are published by the American Forest & Paper Association (AF&PA) in the *National Design Specification ® for Wood Construction (NDS®)*, an ANSI national consensus standard. NDS shear provisions are being revised in the next edition of the NDS in order to utilize new lumber shear design values. However, until revision of the NDS has been completed, 1997 NDS design provisions are only to be used with design values in the 1997 *NDS Supplement: Design Values for Wood Construction*, or similar values.

Until appropriate revisions to the NDS can be fully implemented, the American Forest & Paper Association recommends the following as guidance when using new shear design values with the 1997 or earlier editions of the NDS:

- The shear stress adjustment factor, C_H, for splits, checks, and shakes does not apply to the new shear design values.
- Tension-side notching equations (3.4-3 & 3.4-4) are only to be applied with 1997 *NDS Supplement* design values. These equations are being revised to permit the use of higher lumber shear design values. Until these design provisions are approved, tension-side notches should be designed using existing 1997 NDS design procedures and 1997 *NDS Supplement* design values.
- Provisions in 3.4.5 on shear design for bending members at connections, including equations (3.4-6 & 3.4-7), are only to be applied with 1997*NDS Supplement* design values. These provisions are being revised to permit the use of higher lumber shear design values. Until these design provisions are approved, shear design for bending members at connections should be in accordance with existing 1997 NDS design procedures and 1997*NDS Supplement* design values.
- Alternate design procedures in 4.4.2 do not apply to new shear design values.

For more information on the new shear design provisions for lumber, contact the American Wood Council (AWC) Helpdesk at 202/463-4713 or email awcinfo@afandpa.org.

1111 Nineteenth Street, NW, Suite 800 _ Washington, DC 20036 _ 202 463-2700 Fax: 202 463-2791
America's Forest & Paper People®—*Improving Tomorrow's Environment Today®*

<u>Page</u> **<u>Revision</u>**

32-33 Revise Table 4B as follows:

Species and Commercial Grade	Size Classification
SOUTHERN PINE	
Construction Standard Utility[5]	2" - 4" thick <u>2" -</u> 4" wide
MIXED SOUTHERN PINE	
Construction Standard Utility[5]	2" - 4" thick <u>2" -</u> 4" wide

5. Design values apply to 4" widths only.

1111 Nineteenth Street, NW, Suite 800 _ Washington, DC 20036 _ 202 463-2700 Fax: 202 463-2791
America's Forest & Paper People®—*Improving Tomorrow's Environment Today®*

A F & P A

AMERICAN FOREST & PAPER ASSOCIATION
American Wood Council
Engineered and Traditional Wood Products

2000 Errata
to
1999 Edition of

ASD STRUCTURAL-USE PANELS SUPPLEMENT to the ALLOWABLE STRESS DESIGN (ASD) MANUAL FOR ENGINEERED WOOD CONSTRUCTION

Page **Revision**

4 Revise section 2.1 under Span Ratings as follows:

Span ratings indicate a maximum recommended support spacing, in inches, for specific applications. The span rating system applies when the panel is applied with the strength axis across ~~two~~ three or more supports. The strength axis is usually the primary axis (which is usually the long dimension) of the panel.

5 Revise section 2.1 under Span Ratings as follows:

Single Floor: The Single Floor span rating is an index number that provides the maximum recommended support spacing with the strength axis across ~~two~~ three or more supports. Typical Single Floor span ratings are 20 oc and 24 oc, although 16 oc, 32 oc, and 48 oc Single Floor panels are also available.

21 Revise Table 4.5 Panel Size Factor, C_s, as follows:

Table 4.5 Panel Size Factor, C_s

Panel Width, w	C_s
w≤8 inches	$\cancel{\frac{(8+w)}{32}}$ 0.5
8 inches < w < 24 inches	~~0.5~~ $\frac{(8+w)}{32}$
w≥24 inches	1.0

Future Updates will be available at www.awc.org

1111 Nineteenth Street, NW, Suite 800 _ Washington, DC 20036 _ 202 463-2700 Fax: 202 463-2791
America's Forest & Paper People®—*Improving Tomorrow's Environment Today*®

A F & P A

AMERICAN FOREST & PAPER ASSOCIATION
American Wood Council
Engineered and Traditional Wood Products

April 2000

2000 Errata
to
1999 Edition of

ASD STRUCTURAL CONNECTIONS SUPPLEMENT to the ALLOWABLE STRESS DESIGN (ASD) MANUAL FOR ENGINEERED WOOD CONSTRUCTION

Page	**Revision**
31	Revise Table 12.3A as follows:

Table 12.3A Common Wire or Box Nail Design Values (Z) for Single Shear (two member) Structural Connections[1,2,3]

Structural panel to lumber with structural panel side members with an effective G=0.50[4]		
Side Member Thickness t_s inches	**Penny Weight[6]**	
	Common	**Box**
1	-	6d$^{\cancel{4}\underline{3}}$
	6d$^{\cancel{4}\underline{3}}$	8d
	8d$^{\cancel{4}\underline{3}}$	10d, 12d
1-1/8	-	6d$^{\cancel{4}\underline{3}}$
	6d$^{\cancel{4}\underline{3}}$	8d
	8d$^{\cancel{4}\underline{3}}$	10d, 12d
1-1/4	-	6d$^{\cancel{4}\underline{3}}$
	6d$^{\cancel{4}\underline{3}}$	8d $^{\cancel{4}\underline{3}}$
	8d$^{\cancel{4}\underline{3}}$	10d, 12d
	10d $^{\cancel{4}\underline{3}}$, 12d	20d, 30d

Future Updates will be available at www.awc.org

1111 Nineteenth Street, NW, Suite 800 _ Washington, DC 20036 _ 202 463-2700 Fax: 202 463-2791
America's Forest & Paper People®—*Improving Tomorrow's Environment Today*®

<u>Page</u> **<u>Revision</u>**

32 Revise Table 12.3C as follows:

Table 12.3C Common Wire and Box Nail Lengths, L, and Diameters, D

	30d		40d	
Common Wire Nail	**L, in.**	**D, in.**	**L, in.**	**D, in.**
	4-1/2	**~~0.225~~ <u>0.207</u>**	**~~5-1/2~~ <u>5</u>**	**~~0.225~~ <u>0.244</u>**

1111 Nineteenth Street, NW, Suite 800 _ Washington, DC 20036 _ 202 463-2700 Fax: 202 463-2791

A F & P A®

AMERICAN FOREST & PAPER ASSOCIATION
American Wood Council
Engineered and Traditional Wood Products

September 1998

1998 Identified Errata
to
1997 Edition of

NATIONAL DESIGN SPECIFICATION® (NDS®)
FOR WOOD CONSTRUCTION ANSI/AF&PA NDS-1997

Page	**Revision**
5	Definition for $Z_\perp$ should be:

$Z_\perp$ = nominal lateral design value for a single bolt or lag screw wood-to-wood, wood-to-metal, or wood-to-concrete connection with all wood member(s) loaded perpendicular to grain, lbs.

45 Table 7.3.3 Wet Service Factors, C_M, for Connections, should be revised as follows.
(Note: only changes to table are shown)

Fastener Type	Moisture Content: At Time of Fabrication	Moisture Content: In-Service	Load: Lateral	Load: Withdrawal
Bolts & Drift Pins & Drift Bolts &	~~any~~ ≤ 19% > 19% any	≤ 19% ≤ 19% > 19%	1.0~~[3]~~ 0.4[3] 0.7	- - -
Lag Screws & Wood Screws	~~any~~ ≤ 19% > 19% any	≤ 19% ≤ 19% > 19%	1.0~~[3]~~ 0.4[3] 0.7	1.0 1.0 0.7

~~3. For two or more rows of bolts or lag screws with single steel side plate(s) installed in wood with moisture content >19% at time of fabrication and ≤ 19% in service, C_M = 0.4.~~

3. C_M = 1.0 for wood screws. For bolt and lag screw connections with: 1) one fastener only, or 2) two or more fasteners placed in a single row parallel to grain, or 3) fasteners placed in two or more rows parallel to grain with separate splice plates for each row, C_M = 1.0.

1111 Nineteenth Street, NW, Suite 800 ▮ Washington, DC 20036 ▮ 202 463-2700 Fax: 202 463-2791 ▮ www.awc.org

Page	**Revision**
54	The second sentence of 8.2.3.1 should be revised as follows: "Table 8.2E provides nominal design values for various single shear bolted wood to concrete ~~or masonry~~ connections."
73	In Table 8.3D, "$Z_{1/21/2}$" should be "ZX" and "$Z_{\wedge}$" should be "$Z_{\perp}$".
89	In Table 10.2B, the heading for the first column should be "Shear plate diameter".
132	Section 13.1 - General, should be revised as follows: "Design criteria for timber rivet joints apply to timber rivets that satisfy the requirements of 13.1.1 loaded in single shear, with steel side plates on ~~Western Species~~ Douglas Fir - Larch or Southern Pine glued laminated timber manufactured in accordance with ANSI/AITC A190.1-1992 (Reference 4)."
156	Appendix B, item (e) should be: (e) Load duration factors greater than 1.6 shall not apply to structural members pressure-treated with water-borne preservatives (see Reference 29), or fire retardant chemicals. The impact load duration factor shall not apply to connections.
159	In Equation D-3, "F_{cE}" should be "F_{bE}".