National Design Specification® (NDS®) for Wood Construction

The American Wood Council of the American Forest & Paper Association wrote this document. It was first published in 1944 and the most recent edition was published in 2001, however the 1997 Edition is referenced in…and will be discussed here.

It is developed via the American National Standards Institute consensus procedures and is a standard where "the most reliable data available from laboratory tests and experience with structures in service have been carefully analyzed and evaluated for the purpose of providing, in convenient form, a national standard of practice." It defines itself as “the method to be followed in structural design [with certain wood products and connections].”

This document is of use in seismic retrofit work because it addresses connections that are not found in the Simpson Strong-Tie Catalog or in NER-272. Chapters 2, 8, 9, 11, and 12 are the most useful ones for the user seeking wood or fastener strength properties. These chapters come under the headings "Design Values for Structural Members", "Bolts", "Lag Screws", "Wood Screws", and "Nails and Spikes." For example, if the user wants to know how far from the edge he can place a bolt from the end of the mudsill this information can be found on page 58 of the 1997 NDS. The shear values for nails found in the chapter on "Nails and Spikes" is much more complete than the one found NER-272.

This document also contains engineering formulas that are used by engineers when they come up against a wood frame connection that is not listed in a table. The use of these formulas should be left to engineers. The values listed here are recognized by the 1997 Uniform Building Code via the reference found in Chapter 23 of that code. {The ’97 UBC actually references the 1991 NDS}

It is important for users to understand that the information found in this document should be considered a “published” and therefore legitimate value. Published values are either values found in tables in the NDS or are values that have been “calculated” using the tables in the NDS and modified through the use of engineering formulas.

11.4 Combined Lateral and Withdrawal Loads

11.4.1 Lag Screws and Wood Screws

When a lag screw or wood screw is subjected to combined lateral and withdrawal loading, as when the fastener is inserted perpendicular to the fiber and the load acts at an angle, α, to the wood surface (see Figure 11F), the adjusted design value shall be determined as follows (see Appendix J):

$$Z_\alpha' = \frac{(W'p)Z'}{(W'p)\cos^2\alpha + Z'\sin^2\alpha} \qquad (11.4\text{-}1)$$

where:

α = angle between wood surface and direction of applied load

p = length of thread penetration in main member, in.

11.4.2 Nails and Spikes

When a nail or spike is subjected to combined lateral and withdrawal loading, as when the nail or spike is inserted perpendicular to the fiber and the load acts at an angle, α, to the wood surface, the adjusted design value shall be determined as follows:

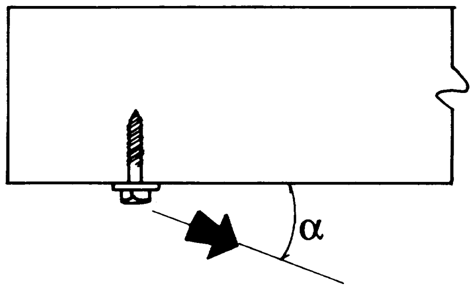
$$Z_\alpha' = \frac{(W'p)Z'}{(W'p)\cos\alpha + Z'\sin\alpha} \qquad (11.4\text{-}2)$$

where:

α = angle between wood surface and direction of applied load

p = length of penetration in main member, in.

Figure 11F Combined Lateral and Withdrawal Loading



11.5 Adjustment of Reference Design Values

11.5.1 Geometry Factor, C_Δ

11.5.1.1 When D < 1/4", $C_\Delta = 1.0$.

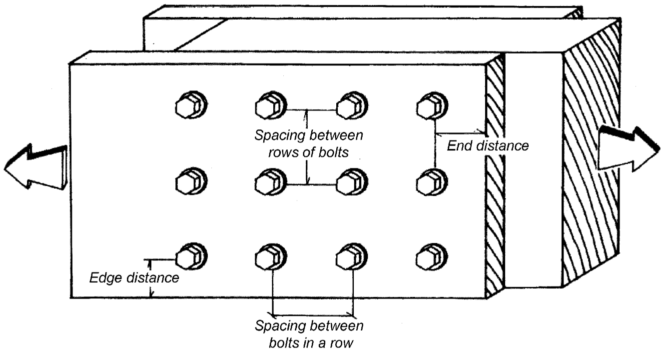
11.5.1.2 When D ≥ 1/4" and the end distance or spacing provided for dowel-type fasteners is less than the minimum required for $C_\Delta = 1.0$ for any condition in (a), (b), or (c), reference design values shall be multiplied by the smallest applicable geometry factor, C_Δ, determined in (a), (b), or (c). The smallest geometry factor for any fastener in a group shall apply to all fasteners in the group. For multiple shear connections or for asymmetric three member connections, the smallest geometry factor, C_Δ, for any shear plane shall apply to all fasteners in the connection. Provisions for C_Δ are based on an assumption that edge distance and spacing between rows of fasteners is in accordance with Table 11.5.1A and Table 11.5.1D and applicable requirements of 11.1.

Table 11.5.1A Edge Distance Requirements [1,2]

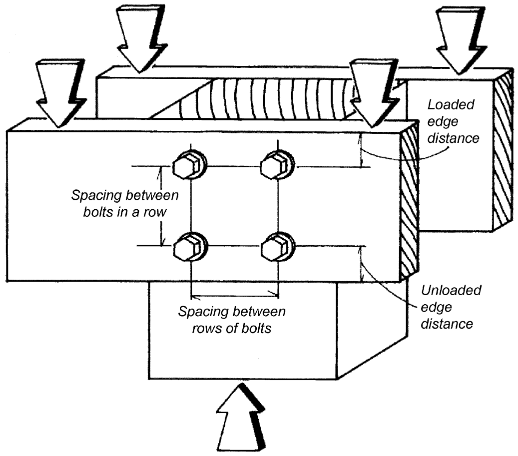
Direction of Loading	Minimum Edge Distance
Parallel to Grain:	
when ℓ/D ≤ 6	1.5D
when ℓ/D > 6	1.5D or ½ the spacing between rows, whichever is greater
Perpendicular to Grain:[2]	
loaded edge	4D
unloaded edge	1.5D

1. The ℓ/D ratio used to determine the minimum edge distance shall be the lesser of:
   (a) length of fastener in wood main member/D = ℓ_m/D
   (b) total length of fastener in wood side member(s)/D = ℓ_s/D
2. Heavy or medium concentrated loads shall not be suspended below the neutral axis of a single sawn lumber or structural glued laminated timber beam except where mechanical or equivalent reinforcement is provided to resist tension stresses perpendicular to grain (see 3.8.2 and 10.1.3).

Figure 11G Bolted Connection Geometry



Parallel to grain loading in all wood members ($Z_{||}$)



Perpendicular to grain loading in the side member and parallel to grain loading in the main member ($Z_{s\perp}$)

(a) When dowel-type fasteners are used and the actual end distance for parallel or perpendicular to grain loading is greater than or equal to the minimum end distance (see Table 11.5.1B) for C_Δ = 0.5, but less than the minimum end distance for C_Δ = 1.0, the geometry factor, C_Δ, shall be determined as follows:

$$C_\Delta = \frac{\text{actual end distance}}{\text{minimum end distance for } C_\Delta = 1.0}$$

(b) For loading at an angle to the fastener, when dowel-type fasteners are used, the minimum shear area for C_Δ = 1.0 shall be equivalent to the shear area for a parallel member connection with minimum end distance for C_Δ = 1.0 (see Table 11.5.1B and Figure 11E). The minimum shear area for C_Δ = 0.5 shall be equivalent to ½ the minimum shear area for C_Δ = 1.0. When the actual shear area is greater than or equal to the minimum shear area for C_Δ = 0.5, but less than the minimum shear area for C_Δ = 1.0, the geometry factor, C_Δ, shall be determined as follows:

$$C_\Delta = \frac{\text{actual shear area}}{\text{minimum shear area for } C_\Delta = 1.0}$$

(c) When the actual spacing between dowel-type fasteners in a row for parallel or perpendicular to grain loading is greater than or equal to the minimum spacing (see Table 11.5.1C), but less than the minimum spacing for C_Δ = 1.0, the geometry factor, C_Δ, shall be determined as follows:

$$C_\Delta = \frac{\text{actual spacing}}{\text{minimum spacing for } C_\Delta = 1.0}$$

Table 11.5.1B End Distance Requirements

Direction of Loading	End Distances: Minimum end distance for C_Δ = 0.5	Minimum end distance for C_Δ = 1.0
Perpendicular to Grain	2D	4D
Parallel to Grain, Compression: (fastener bearing away from member end)	2D	4D
Parallel to Grain, Tension: (fastener bearing toward member end)		
for softwoods	3.5D	7D
for hardwoods	2.5D	5D

Table 11.5.1C Spacing Requirements for Fasteners in a Row

Direction of Loading	Spacing: Minimum spacing	Minimum spacing for C_Δ = 1.0
Parallel to Grain	3D	4D
Perpendicular to Grain	3D	Required spacing for attached members

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