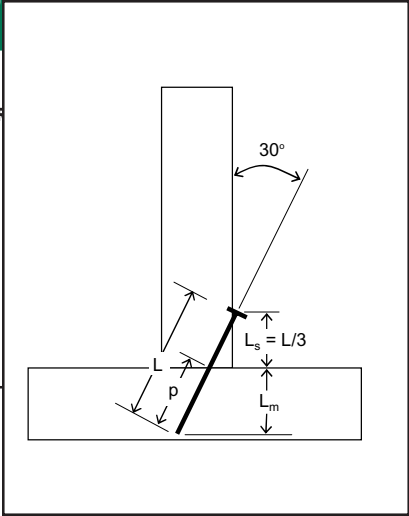
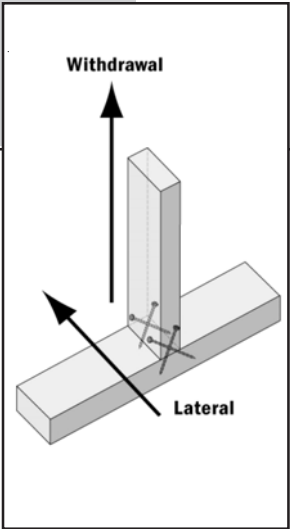
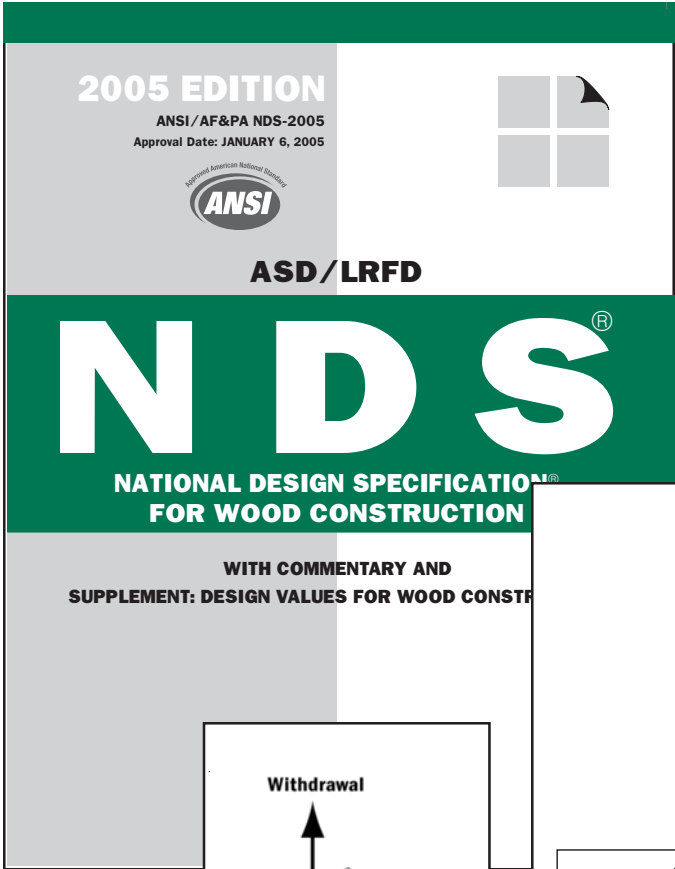
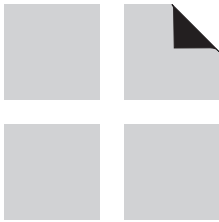


TOENAIL CONNECTIONS



DESIGN AID No. 2

American
Forest &
Paper
Association

DESIGN AID FOR TOENAIL CONNECTIONS

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Introduction

This Design Aid was developed as supplemental information for the *National Design Specification® (NDS®) for Wood Construction* to facilitate the design of connections. These tables are based on provisions of the 2001 and later editions of the *NDS* which are integral to the use and understanding of the tables.

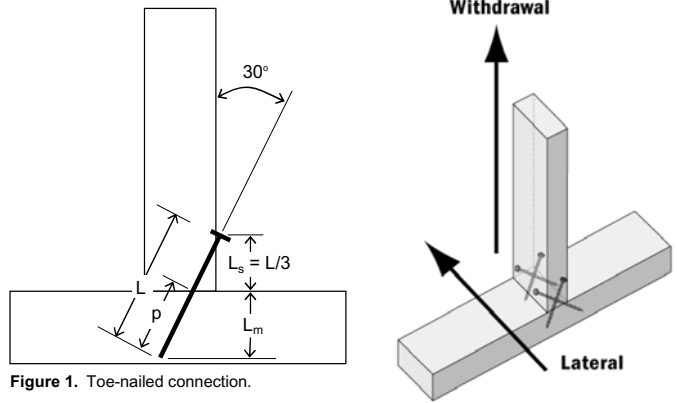


Figure 1. Toe-nailed connection.

Reference Lateral Design Values (Z) for Toe-Nailed Connections^{1,2}

for Sawn Lumber or SCL with both members of identical specific gravity

| Nail Type | Nail Diameter | | | G=0.67 Red Oak | G=0.55 Mixed Maple Southern Pine | G=0.5 Douglas Fir-Larch | G=0.49 Douglas Fir-Larch (N) | G=0.46 Douglas Fir(S) Hem-Fir(N) | G=0.43 Hem-Fir | G=0.42 Spruce-Pine-Fir | G=0.37 Redwood (open grain) | G=0.36 Eastern Softwoods Spruce-Pine-Fir (S) Western Cedars Western Woods | G=0.35 Northern Species | |
|-----------|---------------|----------|-----------------------|-------------------|--|----------------------------|------------------------------------|--|-------------------|---------------------------|-----------------------------------|---|----------------------------|-----------------------|
| | D in. | L in. | L _s in. | | | | | | | | | | | L _m in. |
| Box | 0.099 | 2 | 0.67 | 1.07 | 60 | 50 | 46 | 45 | 42 | 38 | 36 | 30 | 29 | 28 |
| | 0.113 | 2.5 | 0.83 | 1.33 | 78 | 66 | 60 | 59 | 56 | 52 | 50 | 41 | 40 | 38 |
| | 0.128 | 3 | 1.00 | 1.60 | 101 | 84 | 77 | 75 | 71 | 67 | 65 | 55 | 53 | 51 |
| | 0.135 | 3.5 | 1.17 | 1.86 | 112 | 94 | 86 | 84 | 79 | 74 | 73 | 65 | 63 | 60 |
| | 0.148 | 4 | 1.33 | 2.13 | 128 | 107 | 98 | 95 | 91 | 85 | 83 | 74 | 72 | 70 |
| | 0.162 | 5 | 1.67 | 2.66 | 153 | 128 | 117 | 114 | 108 | 101 | 99 | 88 | 87 | 84 |
| Common | 0.113 | 2 | 0.67 | 1.07 | 78 | 65 | 57 | 55 | 50 | 46 | 44 | 37 | 36 | 35 |
| | 0.131 | 2.5 | 0.83 | 1.33 | 105 | 88 | 80 | 77 | 71 | 64 | 62 | 52 | 50 | 48 |
| | 0.148 | 3 | 1.00 | 1.60 | 128 | 107 | 98 | 95 | 91 | 82 | 80 | 66 | 64 | 61 |
| | 0.162 | 3.5 | 1.17 | 1.86 | 153 | 128 | 117 | 114 | 108 | 101 | 99 | 82 | 80 | 76 |
| Sinker | 0.099 | 2.125 | 0.71 | 1.13 | 60 | 50 | 46 | 45 | 43 | 39 | 38 | 31 | 30 | 29 |
| | 0.113 | 2.375 | 0.79 | 1.27 | 78 | 66 | 60 | 59 | 56 | 50 | 48 | 40 | 39 | 37 |
| | 0.120 | 2.875 | 0.96 | 1.53 | 88 | 74 | 68 | 66 | 63 | 59 | 57 | 49 | 47 | 45 |
| | 0.135 | 3.125 | 1.04 | 1.67 | 112 | 94 | 86 | 84 | 79 | 74 | 73 | 61 | 59 | 56 |
| | 0.148 | 3.250 | 1.08 | 1.73 | 128 | 107 | 98 | 95 | 91 | 85 | 83 | 69 | 67 | 64 |

1. Tabulated lateral design values (Z) shall be multiplied by all applicable adjustment factors (see NDS Table 10.3.1). Tabulated lateral design values (Z) have been multiplied by the toe-nail factor, $C_m = 0.83$ as specified in NDS 11.5.4.2.

2. Tabulated lateral design values (Z) are for toe-nailed connections with common wire, box and sinker nails (see NDS Appendix L) installed in accordance with NDS; side and main member thickness sufficient to provide complete embedment of the nail into the wood members; and nail bending yield strengths (F_{yb}): $F_{yb} = 100,000$ psi for $0.099" \leq D \leq 0.142"$; $F_{yb} = 90,000$ psi for $0.142" < D \leq 0.177"$

Reference Withdrawal Design Values (Wp) for Toe-Nailed Connections^{1,2}

in Sawn Lumber or SCL

| Nail Type | Nail Diameter | | | G=0.67 Red Oak | G=0.55 Mixed Maple Southern Pine | G=0.5 Douglas Fir-Larch | G=0.49 Douglas Fir-Larch (N) | G=0.46 Douglas Fir(S) Hem-Fir(N) | G=0.43 Hem-Fir | G=0.42 Spruce-Pine-Fir | G=0.37 Redwood (open grain) | G=0.36 Eastern Softwoods Spruce-Pine-Fir (S) Western Cedars Western Woods | G=0.35 Northern Species | |
|-----------|---------------|----------|-----------------------|-------------------|--|----------------------------|------------------------------------|--|-------------------|---------------------------|-----------------------------------|---|----------------------------|-----------------------|
| | D in. | L in. | L _s in. | | | | | | | | | | | L _m in. |
| Box | 0.099 | 2 | 0.67 | 1.07 | 41 | 25 | 20 | 19 | 16 | 14 | 13 | 9 | 9 | 8 |
| | 0.113 | 2.5 | 0.83 | 1.33 | 59 | 36 | 28 | 27 | 23 | 19 | 18 | 13 | 12 | 12 |
| | 0.128 | 3 | 1.00 | 1.60 | 80 | 49 | 39 | 37 | 31 | 26 | 25 | 18 | 17 | 16 |
| | 0.135 | 3.5 | 1.17 | 1.86 | 99 | 60 | 48 | 45 | 39 | 33 | 31 | 22 | 21 | 19 |
| | 0.148 | 4 | 1.33 | 2.13 | 124 | 76 | 60 | 57 | 48 | 41 | 38 | 28 | 26 | 24 |
| | 0.162 | 5 | 1.67 | 2.66 | 169 | 103 | 81 | 77 | 66 | 56 | 53 | 38 | 36 | 33 |
| Common | 0.113 | 2 | 0.67 | 1.07 | 47 | 29 | 23 | 22 | 18 | 16 | 15 | 11 | 10 | 9 |
| | 0.131 | 2.5 | 0.83 | 1.33 | 68 | 42 | 33 | 31 | 27 | 23 | 21 | 16 | 14 | 14 |
| | 0.148 | 3 | 1.00 | 1.60 | 93 | 57 | 45 | 42 | 36 | 31 | 29 | 21 | 20 | 18 |
| | 0.162 | 3.5 | 1.17 | 1.86 | 119 | 72 | 57 | 54 | 46 | 39 | 37 | 27 | 25 | 23 |
| Sinker | 0.099 | 2.125 | 0.71 | 1.13 | 44 | 27 | 21 | 20 | 17 | 15 | 14 | 10 | 9 | 9 |
| | 0.113 | 2.375 | 0.79 | 1.27 | 56 | 34 | 27 | 26 | 22 | 19 | 17 | 13 | 12 | 11 |
| | 0.120 | 2.875 | 0.96 | 1.53 | 72 | 44 | 35 | 33 | 28 | 24 | 22 | 16 | 15 | 14 |
| | 0.135 | 3.125 | 1.04 | 1.67 | 88 | 54 | 42 | 40 | 34 | 29 | 27 | 20 | 19 | 17 |
| | 0.148 | 3.250 | 1.08 | 1.73 | 101 | 61 | 48 | 46 | 39 | 33 | 31 | 23 | 21 | 20 |

1. Tabulated withdrawal design values (Wp) shall be multiplied by all applicable adjustment factors (see NDS Table 10.3.1). Tabulated withdrawal design values (Wp) have been multiplied by the toe-nail factor, $C_m = 0.67$ as specified in NDS 11.5.4.1.

2. Tabulated withdrawal design values (Wp) are for toe-nailed connections with common wire, box and sinker nails (see NDS Appendix L) with side and main member thickness sufficient to provide complete embedment of the nail in the wood members

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