Technical Bulletin

How to Read ICC-ES Evaluation Service® ESR-1539P©
Part VI Appendices A & B

Preface:

This is the last in a series of technical bulletins designed to provide a greater understanding of the ICC Evaluation Service® evaluation report ESR-1539P© providing information on Appendix A; mathematical formulas for calculating fastener withdrawal, lateral design values for both nails and staples, specific gravity, dowel bearing strength and staple deformation information and Appendix B the recognized products of the listees in ESR-1539P©.

The driven fasteners (nails and staples) described in the evaluation report are used in engineered and non-engineered (prescriptive) structural connections and are primarily installed using power tools. This technical bulletin references **ESR-1539P© Reissue Date 10/2025**. http://www.icc-es.org/Reports/pdf_files/ESR-1539P.pdf

Background:

The first technical bulletin in this series, Terminology Used In ICC Evaluation Service® Report ESR-1539P©, provides a brief description of several technical and administrative terms used.

Part I: Basic ESR Information

Part II: Fastener Basics, Table 1 Nail Types, Tables 2A & 2B Code Fastening Schedules, Table 3 Reference Lateral Design Values 2 by Members

Part III: Table 4A & 4B Reference Nail Head Pull-Through Design Values, Table 5 Lateral Design Values -Steel Side Members to Wood, Table 6 Fastener Withdrawl

Part IV: Shear Wall Allowable Shear Tables

Part V: Framing Tables

Appendix A is divided into three major sections:
Section A1.0 Reference Design Values for Nailed Connections
Section A2.0 Reference Design Values for Stapled Connections
Section A3.0 Design Information for Deflection Calculations for Diaphragms and Shear Walls

Section A1.0 Reference Design Values for Nailed Connections

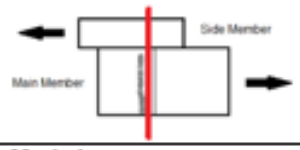
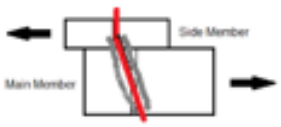
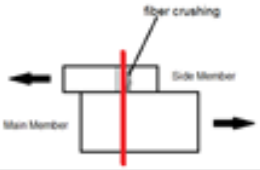
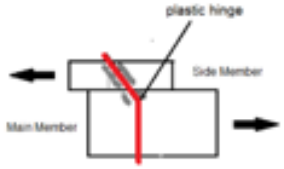
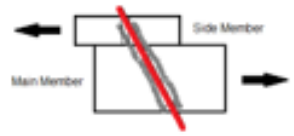
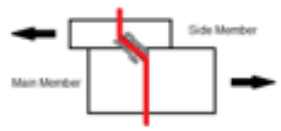
There are four primary topics covered in this section of the appendix. All of the equations in this section are derived from the National Design Specification (NDS®).

Sub Section A1.2 Reference Lateral Design Values:

Reference Lateral Design Value (Z) for nailed connections are calculated from six possible modes. The mode / equation with the lowest resulting value determines the anticipated value of (Z) to be used in the nailed connection. See Figure A for information regarding the six modes and representative equations.

A1.2 Reference Lateral Design Values:

Reference lateral design values are based on the yielding of connections as wood fibers are crushed and/or fastener shanks are bent. Reference lateral design values are determined from the lowest resulting value from six yield limit equations. These equations and depictions of these yield modes are shown below:

For **Mode I_m**  $Z = \frac{D l_m F_{em}}{R_d}$	For **Mode III_m**  $Z = \frac{k_2 D l_m F_{em}}{(1+2R_e)R_d}$
For **Mode I_s**  $Z = \frac{D l_s F_{es}}{R_d}$	For **Mode III_s**  $Z = \frac{k_3 D l_s F_{es}}{(2+R_e)R_d}$
For **Mode II**  $Z = \frac{k_1 D l_s F_{es}}{R_d}$	For **Mode IV**  $Z = \frac{D^2}{R_d}\sqrt{\frac{2F_{em}F_{yb}}{3(1+R_e)}}$

where:

$$K_1 = \frac{\sqrt{R_e + 2R_e^2(1+R_t+R_t^2)+R_e^2R_t^2} - R_e(1+R_t)}{(1+R_e)}$$

$$K_2 = -1 + \sqrt{2(1+R_e)+\frac{2F_{yb}(1+2R_e)D^2}{3F_{em}l_m^2}}$$

$$K_3 = -1 + \sqrt{\frac{2(1+R_e)}{R_e}+\frac{2F_{yb}(2+R_e)D^2}{3F_{em}l_s^2}}$$

Z = *Reference lateral design value, lbf*
R_e = F_{em} / F_{es}
l_m = Length of nail in main member (member holding point), inches
l_s = Length of nail in side member, inches
F_{em} = Dowel bearing strength of main member (member holding point), psi [See 2018 and 2015 NDS Table 12.3.3 (2012 NDS Table 11.3.3)]
F_{es} = Dowel bearing strength of side member, psi [See 2018 and 2015 NDS Table 12.3.3 (2012 NDS Table 11.3.3)]
F_{yb} = Bending yield strength of nail, psi (see Appendix B)
D = Nominal nail diameter, inch (see Appendix B)
R_d = 2.2 for D ≤ 0.17", 10D +0.5 for 0.17 < D < 0.25
R_t = l_m / l_s

Figure A

Sub-Section A1.3 **Reference Withdrawal Design Values.**

The equations for calculating withdrawal design values[1]
for Smooth or Deformed shank carbon steel nails, bright or galvanized (W) is:

$$W = 1380\, G^{5/2}\, D$$ in the in-pound system

The equation for calculating withdrawal design values
for Smooth or Deformed shank stainless steel nails, (W) is:

$$W = 465\, G^{3/2}\, D$$ in the in-pound system

Where G is the wood specific gravity and D is the nominal diameter (inches or mm) of the nail shank. Specific gravity values for the various species of wood can be obtained from Table A in the appendix or in NDS® Table 12.3.3A. (*2012 NDS does not address stainless steel nails*) ESR-1539P© Table 6 provides tabulated withdrawal values for various nail size / specific gravity combinations. Values shown are per inch of penetration.

[1] The metric supplement contains the equations for withdrawal in the SI system

Table A - Assigned Specific Gravity and Dowel Bearing Strength for Selected Wood Species

Data provided in Table A references the specific gravity of various species of wood, the Dowel Bearing Strength (F_e) of a nailed connection as listed in NDS® Table 12.3.3 and the Dowel Bearing Strength referenced in Acceptance Criteria AC201 Table 1.

The equation[2] for determining Dowel Bearing Strength of a staple is:

$$F_e \text{ (stapled)} = F_e \text{ (nailed)} + 900$$

Sub-Section A1.4 Reference Nail Head Pull-Through:

There are two equations[2] for determining nail head pull-through

$$W_H = 690\ \pi\ D_H\ SG_{NDS}^2\ t_{ns} \quad \text{for } t_{ns} \le 2.5\ D_H$$

$$W_H = 1725\ \pi\ D_H^2\ SG_{NDS}^2 \quad \text{for } t_{ns} > 2.5\ D_H$$

Where:

- W_H = Reference nail head pull-through design value in pounds-force
- D_H = Nail head diameter in inches
- t_{ns} = Side member thickness in inches
- SG_{NDS} = The assigned specific gravity of the wood found in Table A of this appendix or in Table 12.3.3A of the NDS.

Section A2.0 Reference Design Values for Stapled Connections

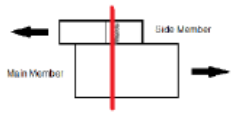
Section A2.0 covers two primary topics
A2.2 Reference Lateral; Design Values
A2.3 Reference Withdrawal Design Values

Sub Section A2.2 Reference Lateral Design Values

There are four equations that have been developed to determine the lateral design value. The minimum result obtained from the equations determines the anticipated design value for the connection (See Figure A)

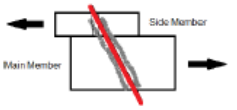
[2] The metric supplement contains the equations for staple dowel bearing strenght and nail head pull-Through in the SI system

Yield Mode I:



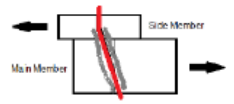
$$Z = \frac{2F_{es}l_s d}{K_D}$$

Yield Mode II:



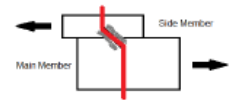
$$Z = \frac{2dF_{em}}{K_D}\left(\frac{l_m}{1+\frac{F_{es}}{F_{em}}}\right)\left[\left|\sqrt{\frac{F_{es}}{F_{em}}+2\left(\frac{F_{es}}{F_{em}}\right)^2\left[1+\frac{l_s}{l_m}+\left(\frac{l_s}{l_m}\right)^2\right]+\left(\frac{F_{es}}{F_{em}}\right)^3\left(\frac{l_s}{l_m}\right)^2}-\frac{F_{es}}{F_{em}}\left(1+\frac{l_s}{l_m}\right)\right|\right]$$

Yield Mode III:



$$Z = \frac{2}{K_D}\left[\frac{-l_s F_{es} d}{2\frac{F_{es}}{F_{em}}+1}+F_{es}d\sqrt{\frac{l_s^2}{\left(2\frac{F_{es}}{F_{em}}+1\right)^2}+\frac{l_s^2}{2\frac{F_{es}}{F_{em}}+1}+\frac{4M}{F_{es}d\left(2\frac{F_{es}}{F_{em}}+1\right)}}\right]$$

Yield Mode IV:



$$Z = \frac{4F_{em}d}{K_D}\sqrt{\frac{M}{F_{em}d\left(1+\frac{F_{em}}{F_{es}}\right)}}$$

where:

Z = Reference lateral design value for staple (2 legs), lbf.

F_{em} = Dowel bearing strength of the main member, psi = 900 psi + F_e from NDS Table 12.3.3 for D<1/4"

F_{es} = Dowel bearing strength of the side member, psi = 900 psi + F_e from NDS Table 12.3.3 for D<1/4"

d = Nominal wire diameter, inch, from Table 3.2.

M = Minimum staple bending moment, in-lbs., from Table 3.2.

l_s = Length of staple in side member, inches.

l_m = Length of staple in main member, inches, (minimum of 12D, where D is the nominal wire diameter from Table 3.2).

K_D = Diameter coefficient for staple connections = 2.2

For SI, see the ISANTA Metric Supplement to ESR-1539.

Figure A

Section A3.0 Design Information for Deflection Calculations for Diaphragms and Shear Walls

SDPWS has provisions for calculating the deflection in diaphragms and shear walls using nails in the connection and the reader of ESR-1539P© is referred to sections 4.2.2 and 4.3.2 for additional information.

For stapled connections, the referenced equations for calculating deflection are contained in sections 2305.2 and 2305.3 of the IBC®. These equations make specific reference to staple deformation (e_n). Table B provides staple deformation values for 16, 15 and 14 gage staples at different staple leg lengths.

Appendix B Recognized Fasteners by Listees

Each member company of ISANTA that is listed in ESR-1539P© receives a product listings table in Appendix B.

Appendix B begins with the names of each listee and the page number associated with that company's listing. This is followed with a section on terminology used in individual listings such as Head Area Ratio (HAR) requirements, shank types and finish/coatings.

Nails listed in ESR-1539P© intended for use in diaphragms, shear walls and braced walls (Lateral Force Resisting Assemblies or LFRA) are required to meet specific HAR requirements described in Acceptance Criteria AC116.

From AC116, "***For alternate head style variations such as clipped heads (for example D-Heads), the minimum head area ratio shall not be less than the minimum head area ratio for the code-prescribed nail of the same diameter***."

Code-prescribed nails used in LFRAs are taken from ASTM F1667. These nails, referred to as common nails, have full round heads with specific dimensional diameters and tolerances. As ESR-1539P© addresses a variety of alternative nails to the nails prescribed in the codes, nails may have heads which differ from those in F1667 Table 14.
Example: An 8d common nail (2½" x 0.131") with an ASTM head diameter of [0.253-0.309] inches has a HAR = 0.72

Nails with shank diameter of 0.131" for each listee were evaluated to determine the HAR value. If a listees 0.131" nail has a HAR equal to or greater than 0.72, a value of Y=8d is assigned to that nail indicating that the

nail meets the requirements for use in LFRAs where an 8d common nail is prescribed in the code.

A similar nomenclature applies to

6d common nails (2" x 0.113")	(Y=6d)
10d common (3" x 0.148")	(Y=10d)
16d common (3½" x 0.162")	(Y= 16d)
0.120" diameter nails	(Y120)
0.135" diameter nails	(Y135)
Nails not meeting requirements	(N)
Nails not applicable	(n/a)

APPENDIX B
Appendix B is information on the fastener recognition for each listee in ESR-1539.

Table B1 (not shown here) provides name and address information for each listee

There are individual tables for each listee providing information on the following topics.

Company Name
Nails (Brand name: xxxx)

TYPE OF COLLATION	NOMINAL DIAMETER		HEAD STYLE	MEETS HEAD AREA RATIO REQUIREMENTS FOR USE IN LFRAs	SHANK TYPE	FINISH / COATING	SPECIFIED BENDING YIELD STRENGTH, F_{yb} (psi)	
	inch	mm					Psi	MPa
Plastic Wire Paper	Typical diameters		Full Round Clipped Offset Round	n/a N Y=6d Y 120 Y=8d Y 135 Y= 10d Y= 16D	S - Smooth R – Ring Sc - Screw	X – Bright HDG – Hot Dip Galvanized EG – Electro-Galvanized MG – Mechanical Galvanized H – Hardened (bright) HT – Heat Treated (bright) HEG – Hardened Electro-galvanized HHDG – Hardened Hot Dip Galvanized HEG – Hardened Electro-Galvanized HTHDG – Heat Treated or hardened hot dip galvanized SS – Stainless Steel	Typical values	
Metal Hardware Nails Designated 'xxx' on the package labeling								
Plastic Wire Paper	Typical diameters		Full Round	n/a	S - Smooth R – Ring Sc – Screw	X, HDG, EG, H, HT, HEG, HHDG HTHDG, SS	Typical values	
STAPLE (Brand names: xxxxx)								
Gage			NOMINAL CROWN WIDTH (inch)			FINISH / COATING		
14 15 16			7/16 minimum allowed Others ½ - 1			X, EG. SS		

Listee Product Tables

The product listing table for each listee is broken down into several columns.

Column 1 indicates the type of nail collation: paper, plastic or wire as was previously discussed in Bulletin II.
Column 2 indicates the nominal diameter of the nail.
Column 3 indicates the style of head - full round, clipped, and offset (round).
Column 4 indicates whether the nail meets the HAR requirements for use in LFRAs
Column 5 indicates the type of nail shank available (S smooth shank, R ring shank, Sc screw shank).
Column 6 indicates type of finish / coating (X –bright, HDG – hot dip galvanized, EG – electro galvanized, SS – stainless steel, H – hardened. etc.
Column 7 indicates Bending Yield (F_{yb}) Strength.

Product tables for each listee are sorted by:

- Head Style (first)
- Nominal Shank Diameter (second)

For those listees who have staples in their listing, information regarding gage, nominal crown width and finish / coatings is listed on the bottom of their table.

Referenced Documents:

ANSI/AWC NDS-2024 National Design Specification for Wood © American Wood Council 2024

ASTM F1667/F1667M-21a Standard Specifications for Driven Fasteners: Nails, Spikes and Staples © ASTM International December 2021

2024, 2021, 2018, 2015 International Building Code (IBC) ®© International Code Council Inc. ®

2024, 2021, 2018, 2015 International Residential Code (IRC) ®© International Code Council Inc. ®

AC116 ICC-ES Acceptance Criteria for Nails © ICC Evaluation Service (ICC-ES) ® September 2024

AC201 ICC-ES Acceptance Criteria for Staples © ICC Evaluation Service (ICC-ES) ® March 2024

ICC-ES Evaluation Report ESR-1539P © ICC Evaluation Service (ICC-ES) ® October 2024

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