ISANTA

The following presentation was made to RICOWI in 2017 and has been updated in 2023

Part 3

Nail Identification and Designations

Roofing Nails

From the previous page, one can see that there are a multitude of "roofing" nails on the market. Some are similar in size and shape while other are substantially different.

Again a key is to know that there are different types, different sizes and different applications

Nail Points

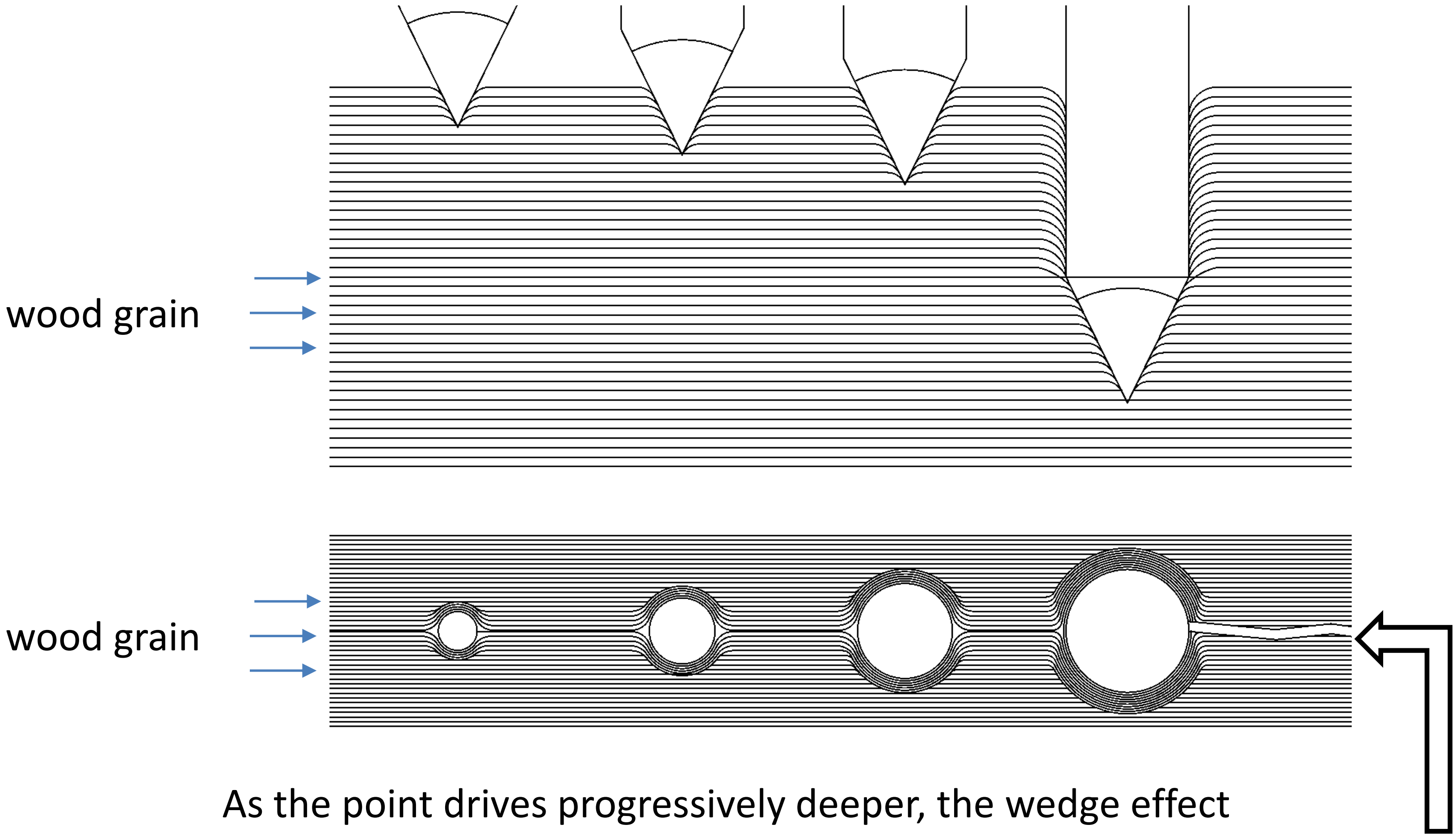
Different Points are used for different applications

Diamond points are the most common point found in construction nails. They work by wedging between the wood fibers. The fibers are displaced around the point as the nail is driven. They are most often used in softwoods such as Douglas Fir, Spruce and Pines. When used with hard woods and very dry wood, there is an increased risk of the wood splitting.

Needle points are less commonly used in engineered construction. Needle points are often used for detailed nailing. Like the diamond point, the needle point creates a wedge that can increase the risk of wood splitting.

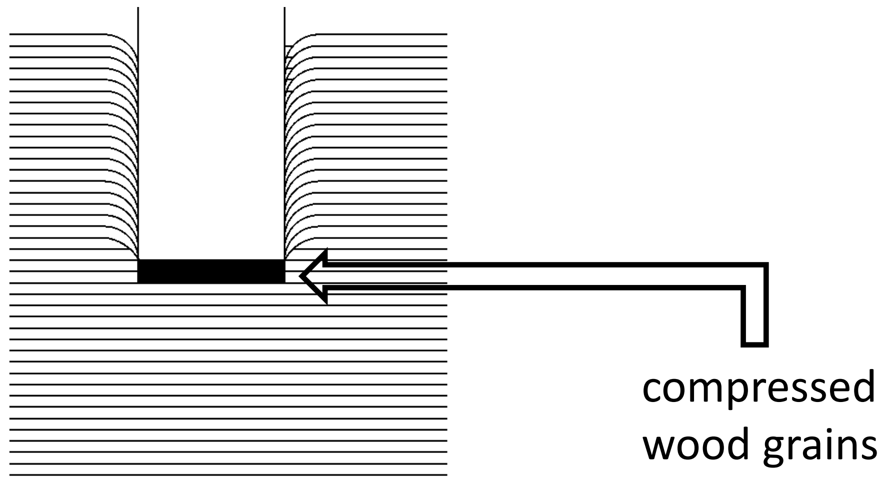
Blunt points are used to reduce wood splitting. The point works by cutting or crushing the wood fiber directly under the diameter and not wedging between the fibers. All of the wood fibers are moved or displaced in one direction under the point instead of around the point. Blunt point are often used in hard woods such as oak, maple, etc. Blunt point nails are more difficult to drive and higher force is required to do so.

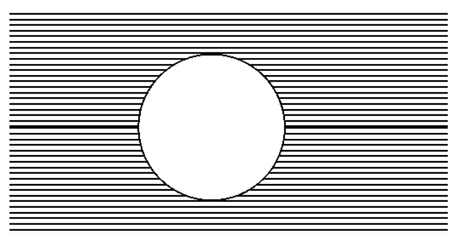
Diamond Nail Points



As the point drives progressively deeper, the wedge effect increases forcing the wood grain apart which <u>may</u> result in wood splitting. Nailing near the edges of the wood increases the chances of wood splitting.

Blunt Nail Points



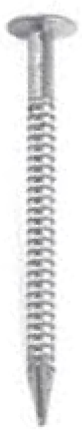


As the blunt point drives progressively deeper, the wood grains are cut, crushed and compressed below the point. There is less "wedging" of the wood grains than with diamond and needle points

Smooth Shank Nails

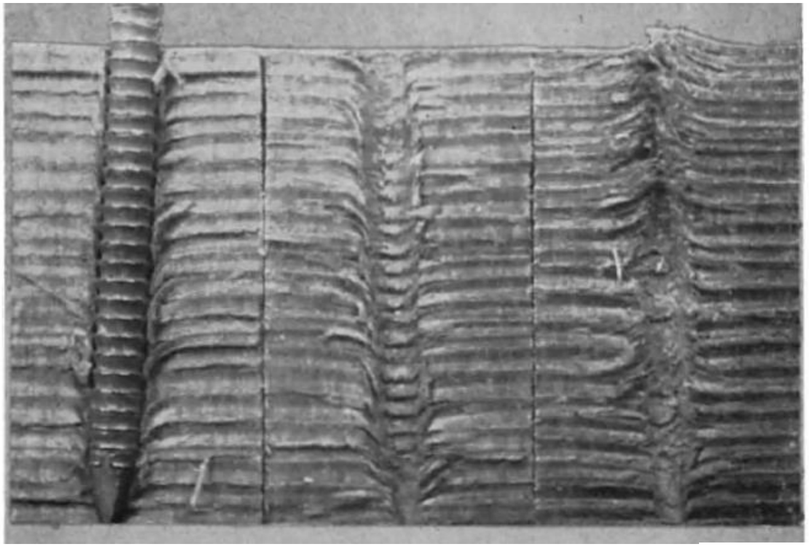
In construction, smooth shank nails are typically used in framing, the attachment of sheathing (plywood and OSB), siding, gypsum and roofing materials among others.

Ring and Screw Shank Nails

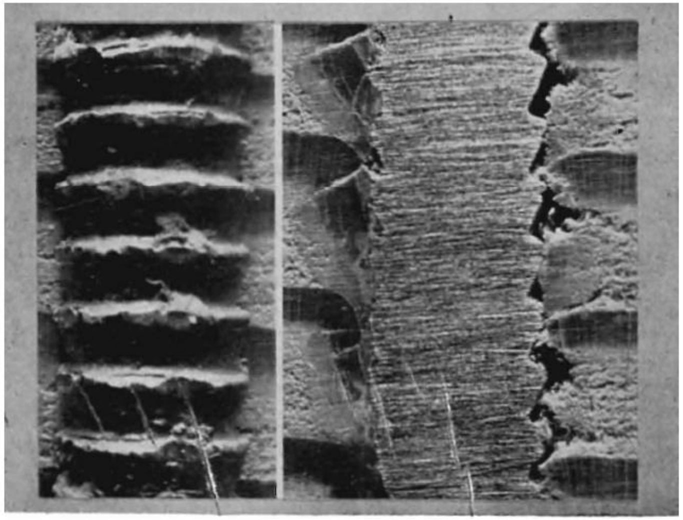


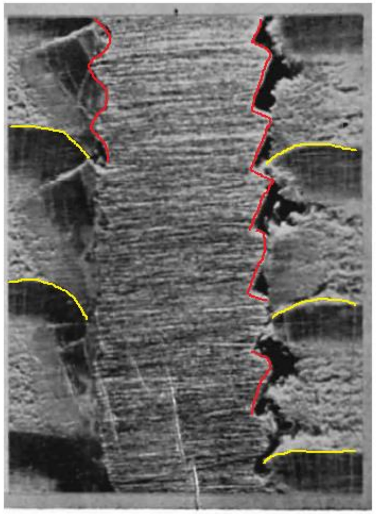
In construction, ring and screw shank nails are typically used in the attachment of sheathing (plywood and OSB), roofing materials and other applications where additional resistance to nail withdrawal is desired such as in high wind and seismic resistant applications.

Ring Shank Nail in Wood



Photos Shows the wood fibers being pushed towards point of the nail





Photos from Research Bulletin 355, The Effectiveness of Roofing Nails for Application of Metal Building Sheets, Iowa State University, Henry Giese and S. Milton Henderson, Published November 1947

Screw Shank Nail in Wood

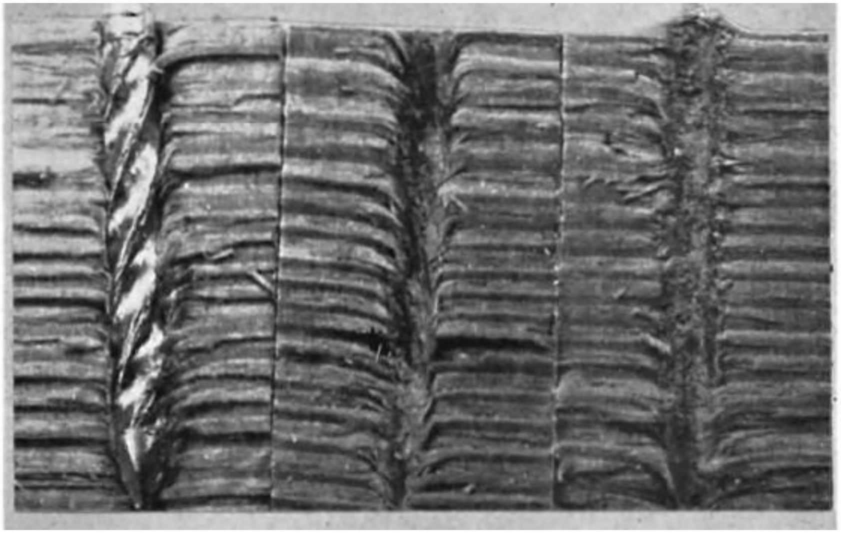
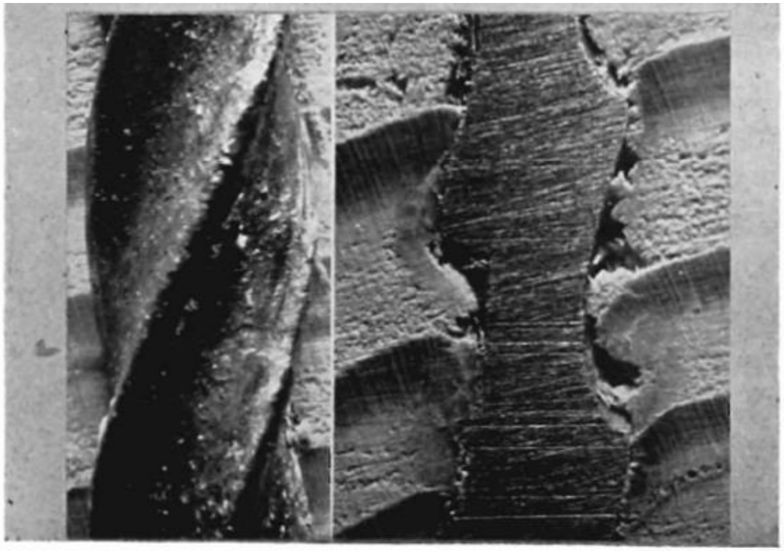
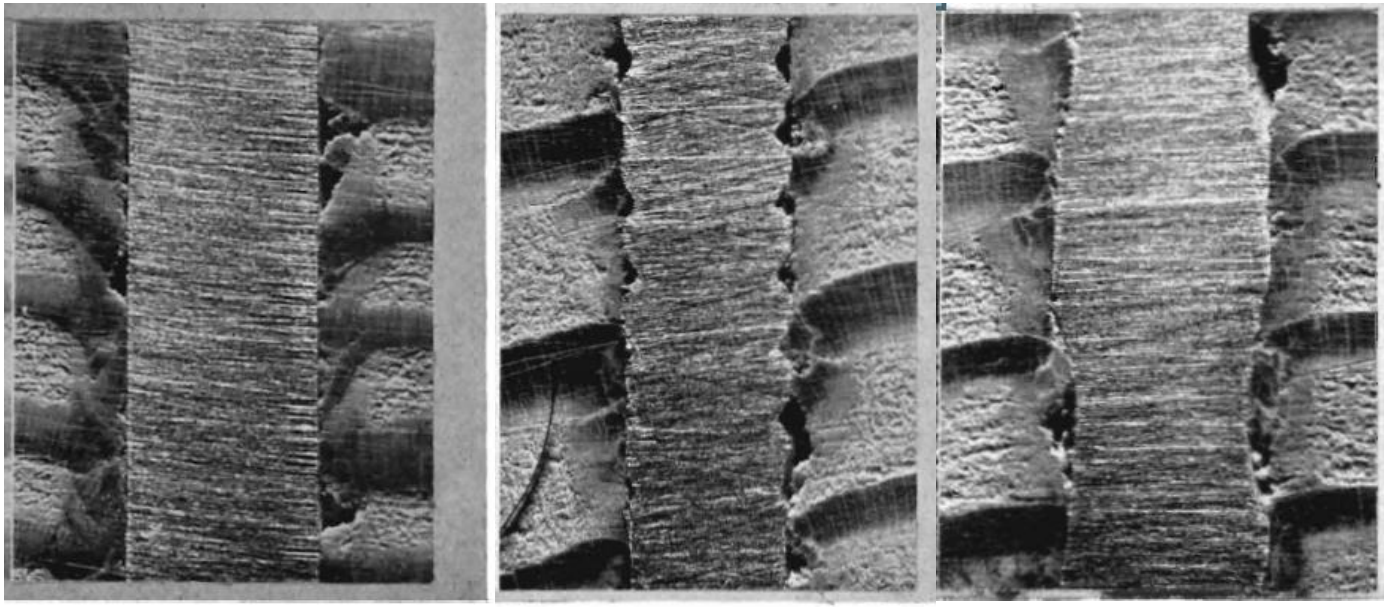


Photo again show the wood fibers being pushed towards the point of nail



Photos from Research Bulletin 355, The Effectiveness of Roofing Nails for Application of Metal Building Sheets, Iowa State University, Henry Giese and S. Milton Henderson, Published November 1947

Cross-section Smooth Shank vs Ring Shank vs. Screw Shank Nail in Wood



Of particular interest in these photos is the contact of the wood fibers to the surfaces of the nail shanks

Photos from Research Bulletin 355, The Effectiveness of Roofing Nails for Application of Metal Building Sheets, Iowa State University, Henry Giese and S. Milton Henderson, Published November 1947

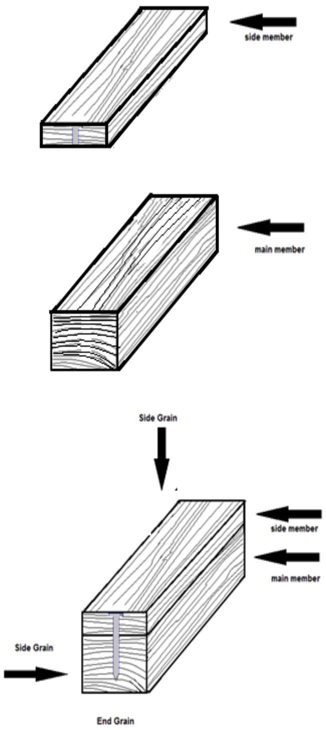
Nail Withdrawal

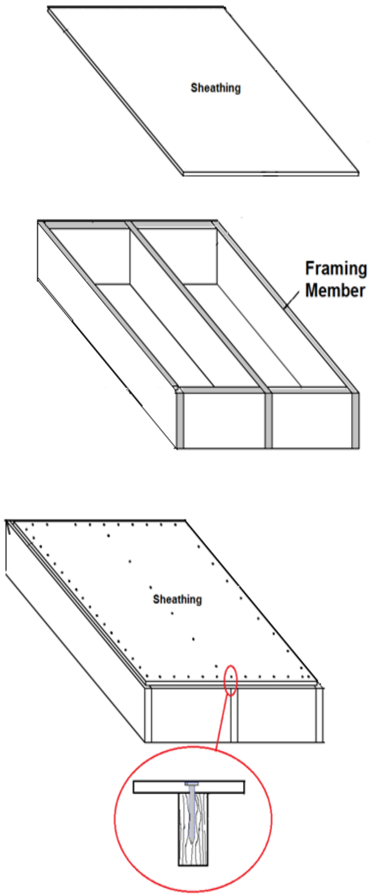
The ability of a nail to resist withdrawal when driven into wood or wood products is critical in building construction. Over the years there have been numerous tests performed that have allowed engineers to develop equations to predict how well a nail will perform in various connections.

Nail withdrawal design values referenced in the American Wood Council's National Design Specification for Wood Construction NDS® are based on wood type (specific gravity)[1], nail shank diameter, and shank configuration and applicable adjustment factors.

[1]Specific Gravity (in the case of wood) is the ratio of the oven-dry mass of a specimen to the mass of water equal to the volume of the wood specimen.

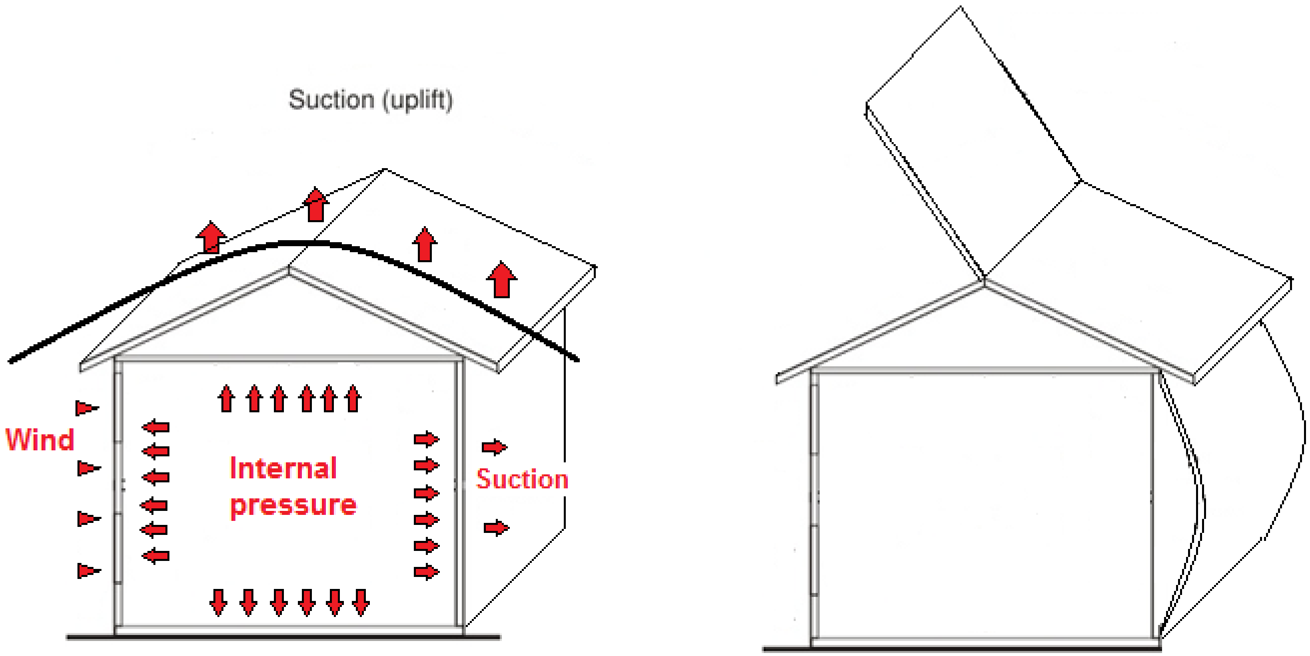
Nail Withdrawal - continued





Withdrawal is based on the penetration of nail into the main member NOT the top or side member. The main member is considered to be the member that holds the point of the nail when two members are nailed together. Engineering calculations used to determine nail withdrawal design values are based on a nail penetrating perpendicular to the side grain. Nailing into the end grain is usually not recommended.

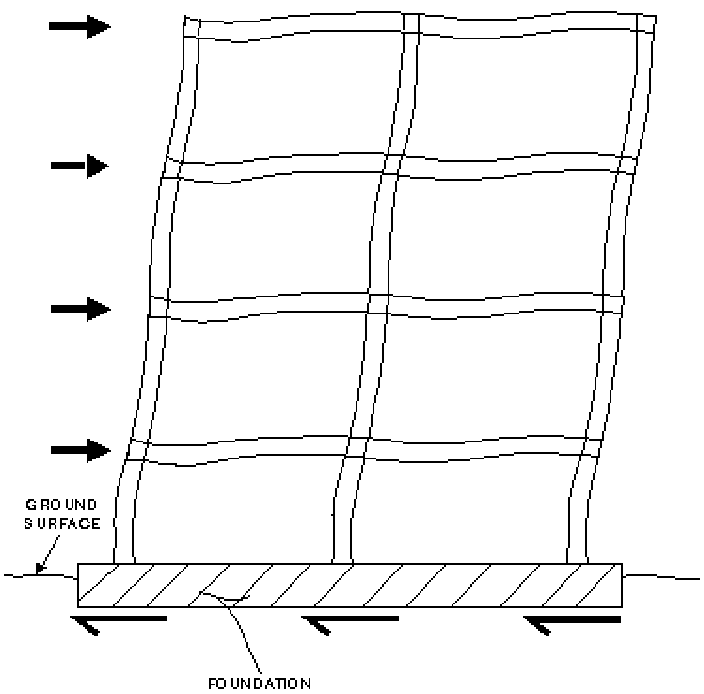
Nail Withdrawal - continued



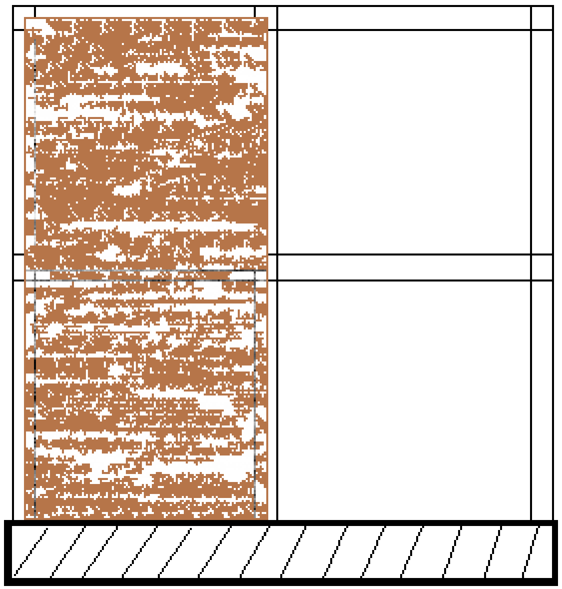
Nail withdrawal under the right conditions can lead to framing and/or sheathing detachment in high wind or seismic events.

Lateral Forces

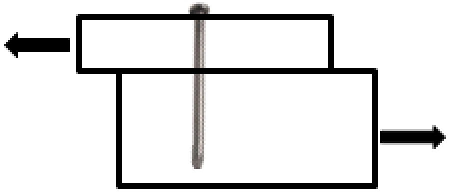
Lateral Forces (loads) are caused by wind or seismic activity that try to twist or push over a structure



Roofs, walls and floors are designed to resist these lateral forces. In the case of wood frame structures this is often accomplished through the use of plywood or OSB sheathing that is nailed to framing members to create lateral force resisting assemblies.



Lateral Forces

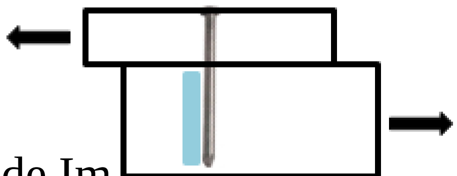


This is a representation of two members nailed together (sheathing and framing). Lateral forces work to shear or cause the members to slide by each other.

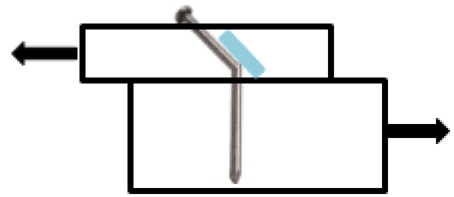
Lateral Forces

When designers take into consideration wind or seismic loading, the strength of the various connections must be analyzed.. There are 6 modes of failure that must be analyzed

fiber crushing in main member



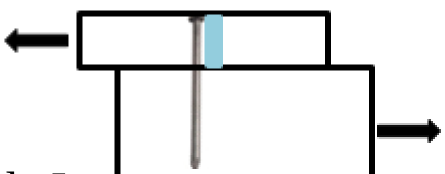
Mode Im



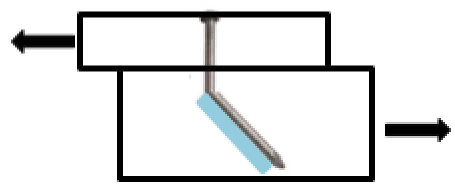
Mode IIIs

fastener develops a plastic hinge with side member fiber crushing

fiber crushing in side member



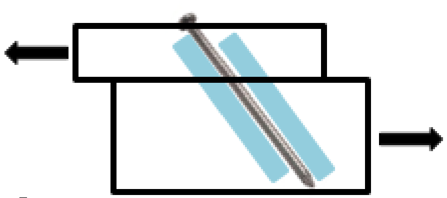
Mode Is



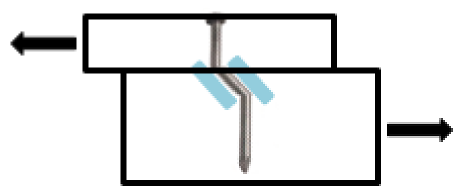
Mode IIIm

fastener develops a plastic hinge with main member fiber crushing

fastener rotates with localized fiber crushing in both members



Mode II



Mode IV

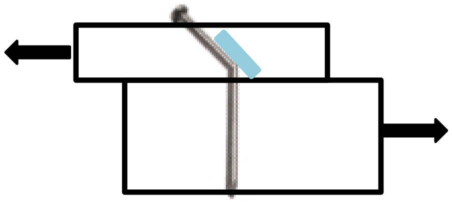
fastener develops two plastic hinges with localized fiber crushing

Lateral Forces

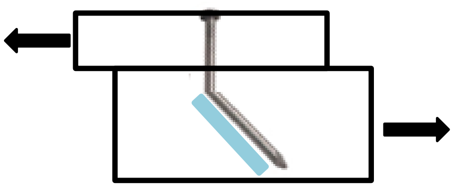
In the three conditions shown below, the nail yields in the connection with some secondary yielding in the wood.

In cases, where the nails yield, the bending yield strength (F_{yb}) is used in the engineering calculations to determine the strength of the connection.

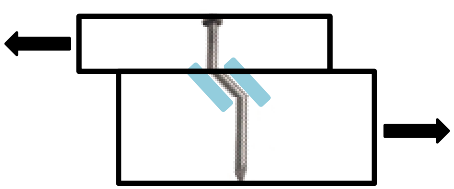
This is why nails used in construction must meet minimum bending yield requirements



fastener develops a plastic hinge with side member fiber crushing



fastener develops a plastic hinge with main member fiber crushing



fastener develops two plastic hinges with localized fiber crushing

Nail Pull Through

Pull through is the process where the nail head pulls through the material(s) being attached. Pull through is usually associated with the side member, but can include both side and main members in extreme cases.

Up to this point in time, pull through has not been specifically addressed in the NDS. Work is presently underway to address nail head pull through. When completed, there should be a method for designers to calculate pull through of fasteners.

photo courtesy of APA-The Engineered Wood Association

Alternatives to Code Prescribed Fasteners

As most users of the I-Codes are aware, the codes prescribe the minimum requirements for materials and components. Alternatives to code prescribed materials can be and are often used in designs and construction. These alternatives are often recognized in evaluation reports. With nails and staples and this is no exception for ISANTA. ICC-ES evaluation report ESR-1539 lists not only alternatives to many of the code prescribed fasteners, but also provides details for withdrawal values, shear capacities and number of fasteners required in framing applications.

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ESR-1539

Reissued 07/2016

This report is subject to renewal 07/2017.

DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES

SECTION: 06 05 23.13—NAILS

REPORT HOLDER:

INTERNATIONAL STAPLE, NAIL AND TOOL ASSOCIATION

8735 WEST HIGGINS ROAD, SUITE 300
CHICAGO, ILLINOIS 60631

EVALUATION SUBJECT:

POWER-DRIVEN STAPLES AND NAILS

Alternatives to Code Prescribed Fasteners

TABLE 1—SCOPE OF NAIL SIZES ADDRESSED IN THIS REPORT[1]

SHANK DIAMETER (inch)	DESCRIBED IN ASTM F1667: TYPE AND PENNYWEIGHT	LENGTH (inches)	HEAD DIAMETER (inch)	SHANK STYLE	OTHERS: COMMONLY AVAILABLE LENGTHS (inches)	SHANK STYLES
0.092	6d cooler	$1^7/_8$	0.250	Smooth	$2^1/_4$	Smooth, Ring, Screw
0.099	6d box	2	0.266	Smooth	2, $2^1/_4$	Smooth, Ring, Screw
0.113	6d common	2	0.266			
0.120						
0.128						
0.131						
0.135						
0.148						
0.162						
0.180						
0.197						

For SI: 1 inch = 25.

[1]See Appendix B fo

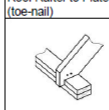
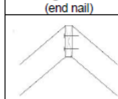
TABLE 4—NAIL AND STAPLE REFERENCE WITHDRAWAL DESIGN VALUES[1,2,3] (pounds-force per inch of penetration)

SPECIFIC GRAVITY[4]	SMOOTH SHANK NAILS, DIAMETER IN INCHES: 0.092	0.099	0.113	0.120	0.131	0.135	0.148	0.162	0.180	0.197	DEFORMED SHANK NAILS, DIAMETER IN INCHES: 0.092	0.099	0.113	0.120	0.131	0.135	0.148	STAPLE GAGE AND DIAMETER, in inches: 16 gage 0.063	15 gage 0.072	14 gage 0.080
0.31	7	7	8	9	10	10	11	12	13	15	7	8	9	10	11	11	12	9	11	12
0.35	9	10	11	12	13	14	15	16	18	20	10	11	12	13	14	15	16	13	14	16
0.36	10	10	12	13	14	14	16	17	19	21	11	11	13	14	15	16	17	13	15	17
0.37	10	11	13	14																
0.38	11	12	14	15																
0.39	12	13	15	16																
0.40	13	14	16	17																
0.41	14	14	17	18																
0.42	14	15	18	19																
0.43	15	16	19	20																
0.44	16	17	20	21																
0.46	18	19	22	24																
0.47	19	20	24	25																
0.49	21	22	26	28																
0.50	22	24	28	29																
0.51	23	25	29	31																
0.55	28	30	35	37																
0.58	32	34	40	42																
0.67	46	49	57	61																
0.68	48	51	59	63																
0.71	53	57	66	70																
0.73	57	61	71	75																

TABLE 5—ALLOWABLE SHEAR FOR WIND OR SEISMIC LOADING FOR WOOD STRUCTURAL PANEL HORIZONTAL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE AND STRUCTURAL I SHEATHING (plf)[1,2,3,4,5,6,7,8,9]

NOMINAL NAIL DIAMETER (inch) OR STAPLE GAGE	MINIMUM REQUIRED FASTENER LENGTH (inches)	MINIMUM WIDTH OF FRAMING MEMBER (inches)	BLOCKED DIAPHRAGMS — FASTENER SPACING (inch) AT DIAPHRAGM BOUNDARIES (ALL CASES), AT CONTINUOUS PANEL EDGES PARALLEL TO LOAD (CASES 3, 4), AND AT ALL PANEL EDGES (CASES 5 & 6): 6		4		$2^1/_2$		2		UNBLOCKED DIAPHRAGMS — FASTENERS SPACED 6" MAX. AT SUPPORTED EDGES: Case 1 (No unblocked edges or continuous joints parallel to load)		All other configurations (Cases 2, 3, 4, 5 & 6)	
			Nail spacing at other panel edges (Cases 1, 2, 3 & 4): 6		6		4		3					
			Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind
$^3/_8$-inch Nominal Panel Thickness														
0.131 smooth or deformed	$1^3/_4$	2 3	270 300	375 420	360 400	505 560	530 600	740 840	600 675	840 945	240 265	335 370	180 200	255 280
0.120 smooth or deformed	$1^3/_4$	2 3	230 255	320 360	305 340	435 480	455 510	635 720	515 580	720 810	200 225	290 320	150 170	220 240
0.113 smooth or deformed	$1^3/_4$	2 3	205 230	290 325	275 305	390 430	410 460	570 645	465 520	645 725	180 205	260 285	135 155	200 215
14, 15, 16 Gage	$1^1/_2$ Leg Ler													
0.148 smooth	2													
0.131 smooth or deformed	2													
0.120 smooth or deformed	2													
0.113 smooth or deformed	2													
14, 15, 16 Gage	$1^1/_2$ Leg Ler													

See page 10 for footnote explanations and c

CONNECTION DESCRIPTION	MINIMUM FASTENING REQUIREMENTS PRESCRIBED IN THE CODE — 2012 IBC Table 2304.9.1: #	Nail Size (Type, inch)	2012 IRC Table R602.3(1): #	Nail Size (Type, inch)	2015 IBC Table 2304.10.1: #	Nail Size (Type, inch)	2015 IRC Table R602.3(1): #	Nail Size (Type, inch)	ALTERNATIVE FASTENING REQUIREMENTS: #	Nail Size (Type, inch)	#	Nail Size (Type, inch)	#	Nail Size (Type, inch)
Roof Rafter to Plate (toe-nail)	Connection 19		Connection 5		Connection 6		Connection 6							
	3	8d com ($2^1/_2$ x .131)	3	10d com (3 x .148)	3	10d com (3 x .148)	3	10d com (3 x .148)	3	16d com ($3^1/_2$ x .162)	4	3 x .131		
	3	3 x .131	3	16d box ($3^1/_2$ x .135)	3	16d box ($3^1/_2$ x .135)	3	16d box ($3^1/_2$ x .135)	3	12d com ($3^1/_4$ x .148)	4	8d com ($2^1/_2$ x .131)		
					4	3 x .131	4	3 x .131	3	10d com (3 x .148)	4	$3^1/_4$ x .120		
					4	10d box (3 x .128)	4	10d box (3 x .128)	3	16d box ($3^1/_2$ x .135)	4	3 x .120		
									4	$3^1/_4$ x .131				
	+ connectors per IBC Section 2308.10.1				+ connectors per IBC Section 2308.7.5				+ connectors per IBC		+ connectors per IBC			
ridge beam (end nail)	Connection 28b		Connection 6		Connection 7a		Connection 7b							
	2	16d com ($3^1/_2$ x .162)	4	16d box ($3^1/_2$ x .135)	2	16d com ($3^1/_2$ x .162)	2	16d com ($3^1/_2$ x .162)	3	16d com ($3^1/_2$ x .162)	4	$3^1/_4$ x .131		
	3	3 x .131			3	3 x .131	3	16d box ($3^1/_2$ x .135)	4	16d com ($3^1/_2$ x .162)	4	3 x .131		
					3	10d box (3 x .128)	3	3 x .131	4	10d com (3 x .148)	5	$3^1/_4$ x .120		
							3	10d box (3 x .128)	4	16d box ($3^1/_2$ x .135)	5	3 x .120		
Roof Rafter to 2 by ridge beam (toe nail)	Connection 28a		Connection 6		Connection 7b		Connection 7a							
	2	16d com ($3^1/_2$ x .162)	4	16d box ($3^1/_2$ x .135)	3	10 com (3 x .148)	3	10 com (3 x .148)	3	16d com ($3^1/_2$ x .162)	5	8d com ($2^1/_2$ x .131)		
	3	3 x .131			3	16d box ($3^1/_2$ x .135)	4	16d box ($3^1/_2$ x .135)	4	12d com ($3^1/_4$ x .148)	6	$3^1/_4$ x .120		
					4	3 x .131	4	3 x .131	4	10d com (3 x .148)	6	3 x .120		
					4	10d box (3 x .128)	4	10d box (3 x .128)	4	16d box ($3^1/_2$ x .135)	6	8d box ($2^1/_2$ x .113)		
									5	$3^1/_4$ x .131	6	$2^3/_8$ x .113		
									5	3 x .131	6	6d com (2 x .113)		

Staples - 101

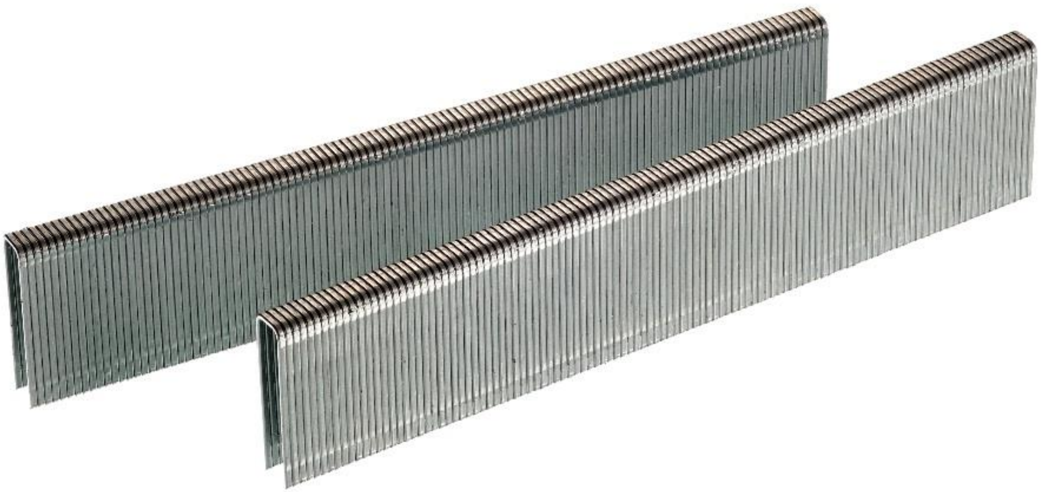


Photo courtesy of Senco Brands

Staples - 101

What is a staple?

A type of two-pronged fastener, made from wire, used for joining material together. Staples driven by a stapler are normally collated into strips. Staples driven by a hammer are normally individually packaged.

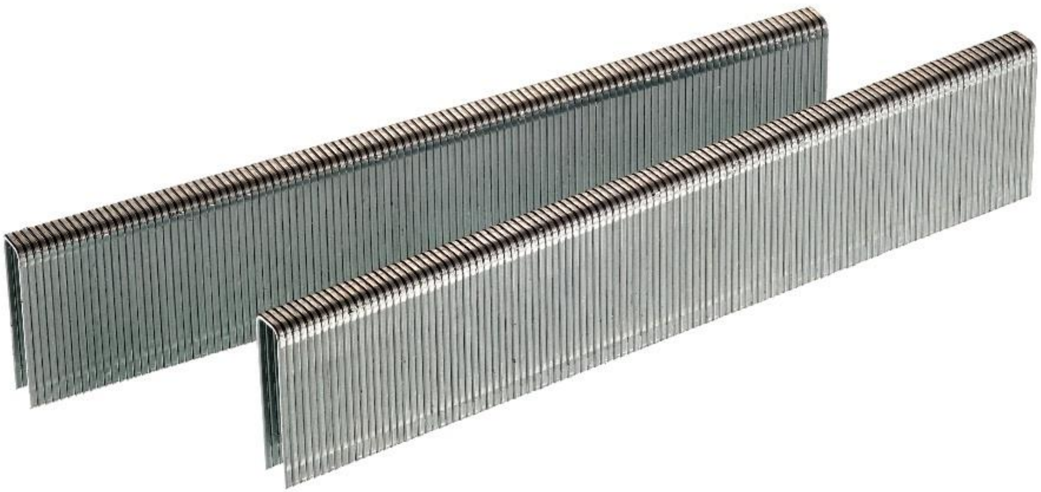


Photo courtesy of Senco Brands

Staples - 101

Materials of Construction

Steel Bright or Galvanized

Stainless Steel

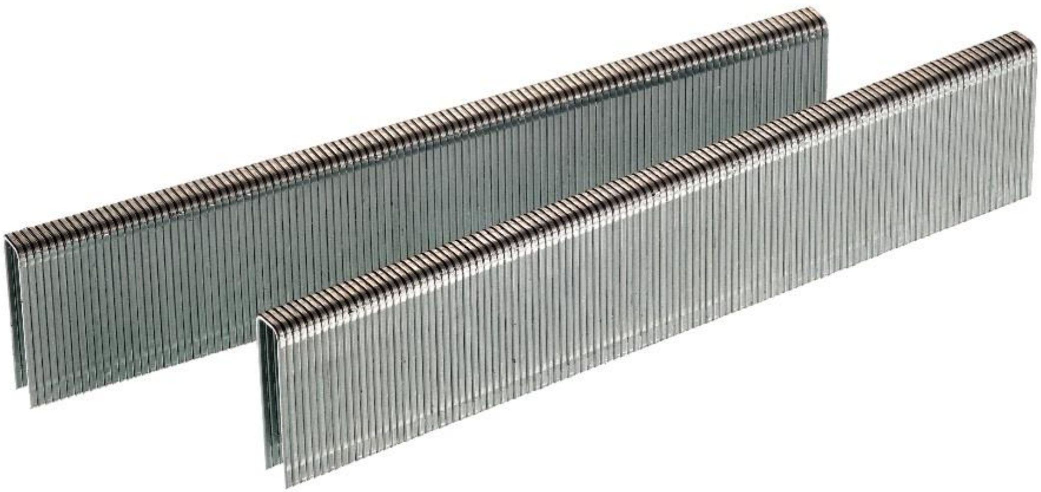


Photo courtesy of Senco Brands

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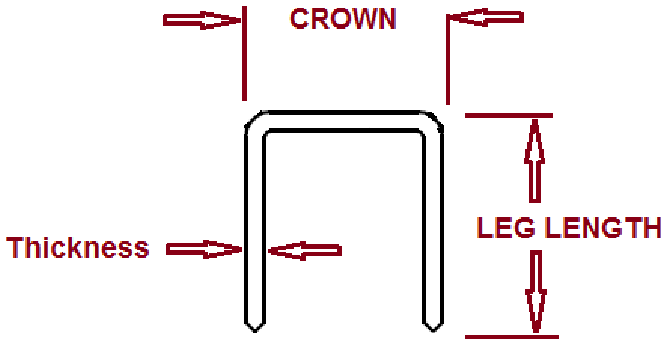
Staples - 101

The Basic components of a staple are the crown and the leg.
The round wire used to form the staple is typically flattened in the manufacturing process. This produces a wire thickness and width in lieu of a typical diameter.



Flat Top Crown Staples are the most common type of staple used in construction. Unlike nails, these staples are almost exclusively listed by gage size vs. diameter size. 14, 15 & 16 are the sizes listed in the IRC and IBC for framing and attachment of sheathing. The minimum crown width is 7/16 inches in these applications.

Staples - 101

Just like nails, development of values for staple withdrawal and lateral shear strength have been developed.

SPECIFIC GRAVITY[4]	STAPLE GAGE AND DIAMETER, in inches		
	16 gage	15 gage	14 gage
	0.063	0.072	0.080
0.58	44	51	57
0.67	63	73	81
0.68	66	76	84
0.71	73	84	94
0.73	79	90	101

TABLE 5—ALLOWABLE SHEAR FOR WIND OR SEISMIC LOADING FOR WOOD STRUCTURAL PANEL HORIZONTAL DIAPHRAGMS WITH FRAMING OF DOUGLAS FIR-LARCH OR SOUTHERN PINE AND STRUCTURAL I SHEATHING (plf)[1,2,3,4,5,6,7,8,9]

NOMINAL NAIL DIAMETER (inch) OR STAPLE GAGE	MINIMUM REQUIRED FASTENER LENGTH (inches)	MINIMUM WIDTH OF FRAMING MEMBER (inches)	BLOCKED DIAPHRAGMS								UNBLOCKED DIAPHRAGMS			
			FASTENER SPACING (inch) AT DIAPHRAGM BOUNDARIES (ALL CASES), AT CONTINUOUS PANEL EDGES PARALLEL TO LOAD (CASES 3, 4), AND AT ALL PANEL EDGES (CASES 5 & 6)								FASTENERS SPACED 6" MAX. AT SUPPORTED EDGES			
			6		4		2 1/2		2		Case 1 (No unblocked edges or continuous joints parallel to load)		All other configurations (Cases 2, 3, 4, 5 & 6)	
			Nail spacing at other panel edges (Cases 1, 2, 3 & 4)											
			6		6		4		3					
			Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind	Seismic	Wind
3/8-inch Nominal Panel Thickness														
14, 15, 16 Gage	1 1/2 Leg Length	2	175	245	235	330	350	490	400	560	155	215	115	160
		3	200	280	265	370	395	550	450	630	175	245	130	180
15/32-inch Nominal Panel Thickness														
14, 15, 16 Gage	1 1/2 Leg Length	2	175	245	235	330	350	490	400	560	155	215	120	160
		3	200	280	265	370	395	550	450	630	175	245	130	180

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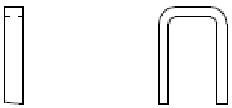
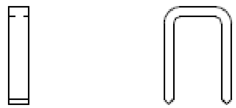
Staples are manufactured with a variety of points and are tailored for specific applications.



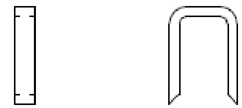
A - BLUNT POINT

DRIVES THROUGH ENTIRE LEG LENGTH IN TOUGH GRAINY WOODS. ALSO USED IN LIGHT SHEET METAL APPLICATIONS.



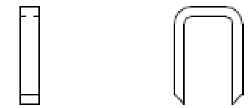
B - CHISEL POINT

KEEPS STAPLE LEGS PARALLEL TO THE DEPTH OF THE ENTIRE LEG LENGTH. RECOMMENDED FOR GRAINY WOODS. AT PRESENT TIME OUR MOST POPULAR POINT.



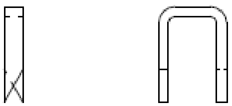
C - INSIDE CHISEL POINT

USED FOR OUTWARD CLINCHING AGAINST STEEL PLATE AFTER PENETRATION THROUGH MATERIAL BEING STAPLED.



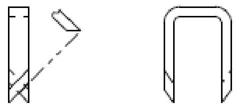
D - OUTSIDE CHISEL POINT

FOR INWARD CLINCHING AGAINST STEEL PLATE AFTER PENETRATION THROUGH MATERIAL BEING STAPLED.



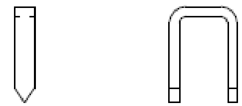
F - DIVERGENT POINT

AFTER PENETRATION THE LEGS DIVERGE TO ALLOW A LONGER LENGTH STAPLE TO BE USED AND REMAIN WITHIN THE CONFINES OF THE MATERIAL THICKNESS.



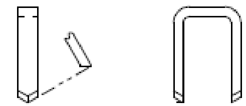
G - OUTSIDE CHISEL DIVERGENT POINT

EXCELLENT PENETRATION AND DIVERGING QUALITIES. THE LEGS CROSS ONE ANOTHER AND LOCK THE STAPLE IN POSITION. RECOMMENDED FOR CLINCHING AGAINST STEEL.



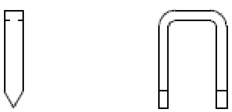
H- CROSS-CUT CHISEL POINT

HAS SIMILAR CHARACTERISTICS AS A CHISEL POINT. KEEPS STAPLE LEGS PARALLEL TO A DEPTH OF THE ENTIRE LEG LENGTH. RECOMMENDED FOR GRAINY WOODS.



J - CROSS-CUT CHISEL DIVERGENT POINT

GOOD PENETRATION IN GRAINY WOODS AS WELL AS HOLDING POWER.

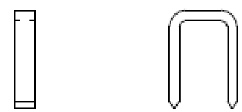


K - SPEAR POINT

GOOD PENETRATION IN UNEVEN DENSITY MATERIAL. POINT WILL DEFLECT UPON STRIKING OBSTRUCTIONS.

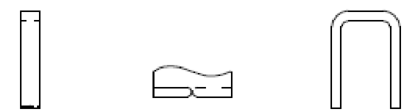
L - CHISEL DIVERGENT POINT

HAS EXCELLENT PENETRATION ABILITY IN HARD WOODS. LEGS WILL DIVERGE PERPENDICULAR TO THE STAPLE CROWN AND IN OPPOSITE DIRECTIONS FROM ONE ANOTHER.



N - SHARP CHISEL POINT

HAS SIMILAR CHARACTERISTICS AS A CHISEL POINT. KEEPS STAPLE LEGS PARALLEL TO THE DEPTH OF THE ENTIRE LEG LENGTH. RECOMMENDED FOR GRAINY WOODS.

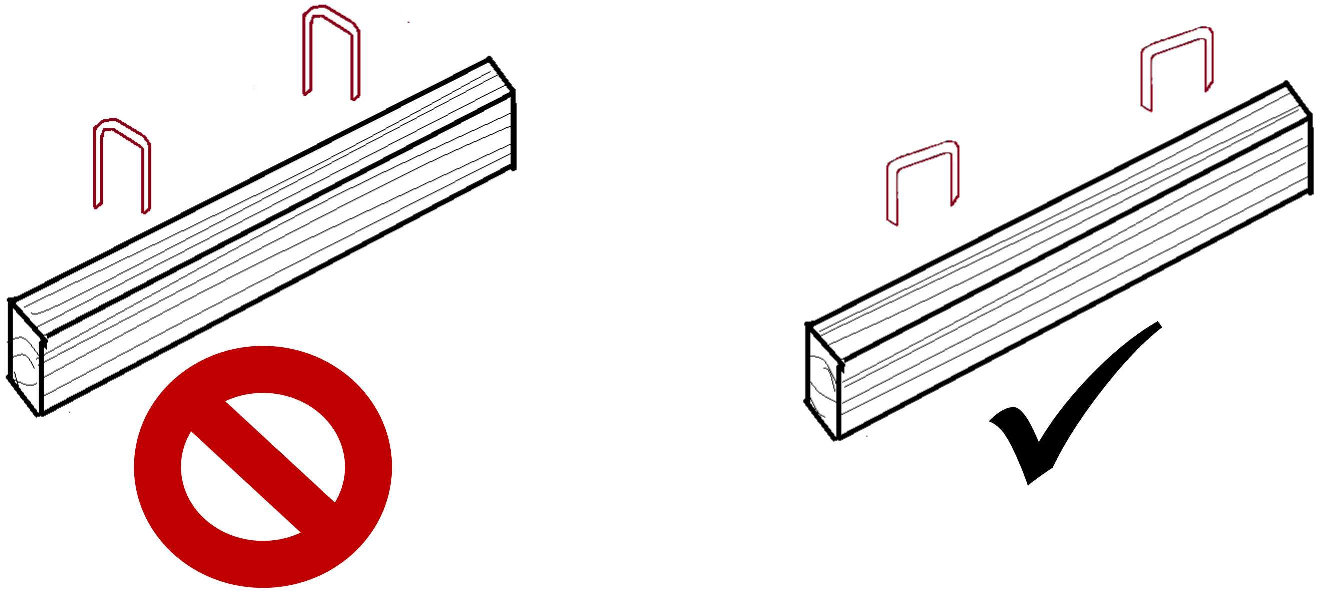


R - STEP POINT

USED FOR HEAVY DUTY CLINCHING AGAINST STEEL PLATES AFTER PENETRATING THROUGH MATERIAL.

Staples - 101

When used for the attachment of structural sheathing the staple crowns shall be installed parallel to the long dimension of the framing members[1].



[1] Referenced in the footnotes for IBC Tables 2306.2(1), 2306.2(2), 2306.3(1), 2306.3(3) and ESR-1539 Table 5-8

Staples - 101

In addition, staples are also supplied as cap staples. These fasteners are designed to minimize tearing and to provide watertight sealing for underlayment and wall wrap. The caps and staples are assembled at installation in the application tooling.

Cap Staples were added to the IRC in 2015 with plans to add to the IBC in 2018 for the attachment of underlayment.

The minimum requirements are 21 gage corrosion resistant wire on the staple legs with 1 inch diameter caps.

Thank You

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