# Codes and Standards

updates and discussions related to codes and standards

*Years ago, in the early days of my career, if you had told me that fasteners could be fascinating, I would have thought you had a screw loose. (Yes, of course the pun was intended!) Today, I can't think of another type of building component that comes in more varieties and performs more functions. It is difficult to imagine what buildings would be like without fasteners.*

## What's So Fascinating About Fasteners?

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This article is intended to provide information about Fasteners and related ICC-ES acceptance criteria. It should not be construed as an endorsement or recommendation by ICC-ES®.

Fasteners used as structural building components include nails, screws and power-driven pins. These products are generally manufactured from steel wire and typically have diameters of ¼ inch or less. They are used as repetitive elements and, unlike bolts and post-installed concrete anchors, fasteners are installed in one operation. The point of the fastener is driven through all of the connected materials, without the need for nuts or other components on the back side of the material. There are typically at least three zones of interest along the length of a fastener: the point or tip; the body or shank; and the head. The design of each of these zones can vary greatly depending upon the intended use of the fastener.

While the 2009 *International Building Code®* (IBC) and 2009 *International Residential Code®* (IRC) address requirements for the use of traditional fasteners such as nails, the codes do not address all of the available types of fasteners and novel applications of these products. The code shows awareness of this by requiring the use of fasteners which comply with a named standard *or with an approved design or alternate* (e.g., Section D1 of AISI S200) and by generally allowing for alternate materials (IBC Section 104.11), but does not stipulate how to judge an alternate design. Fortunately, ICC Evaluation Service (ICC-ES) addresses suitability of alternate designs, ongoing quality control of structural fasteners, and innovations in fastener design.

Fastener products are recognized in ICC-ES Evaluation Service Reports (ESRs), based on documents known as Acceptance Criteria (AC). These documents have been developed by ICC-ES in conjunction with industry experts and approved by the ICC-ES Evaluation Committee, which is comprised solely of code officials. These ACs are public documents available on the ICC-ES website. As manufacturers continue to develop new fastener designs and applications, these ACs will be revised and expanded, and new ACs may be developed. Currently, the ICC-ES ACs applicable to fastener evaluations are as follows:

- Fasteners Power-driven into Concrete, Steel, and Masonry Elements (AC70)
- Nails and Spikes (AC116)
- Tapping Screw Fasteners (AC118)
- Wood Screws Used in Horizontal Diaphragms, Vertical Shear Walls and Braced Walls (AC120)

*It may be easy to lump all fasteners together, but each type of fastener has unique applications and capabilities. Courtesy of Thinkstock.*

- Staples (AC201)
- Power-driven Pins for Shear Wall Assemblies with Cold-formed Steel Framing and Wood Structural Panels (AC230)
- Alternate Dowel Type Threaded Fasteners (AC233)
- Corrosion-resistant Fasteners and Evaluation of Corrosion Effects of Wood Treatment Chemicals (AC257)
- Power-driven Pins for Attaching Gypsum Board Materials to Cold-formed Steel Wall Framing (AC259)
- Horizontal Diaphragms Consisting of Wood Structural Panel Sheathing Attached to Cold-formed Steel Framing (AC262)

### Power-driven Fasteners

Power-driven fasteners, sometimes referred to as power-driven pins or shotpins, are installed using tools which exert an extremely high force on the fastener either by igniting a charge of gunpowder (powder-actuated fasteners) or igniting a measure of compressed gas (gas-driven or gas-actuated). Power-driven fasteners often resemble common nails, but are used to attach materials to base materials which are much harder and stronger than wood, including concrete, steel and masonry. To achieve this, the fasteners are typically case-hardened to a Rockwell C hardness of 50 or more. Since there is currently no national standard for these fasteners, they must be evaluated in accordance with AC70.

Many different power-driven fasteners have been recognized in ICC-ES evaluation reports. Variations in shank design include straight, tapered or stepped shanks, which can be either smooth or knurled. Flat heads are sometimes

replaced with threaded portions to create power-driven studs. Various accessories can be factory affixed to the fasteners to create assemblies for special uses. Examples include ceiling clips, threaded rod hangers and a variety of washers.

While AC70 is the basis for evaluating power-driven fasteners installed in steel with a thickness of 3/16 inch or more, power-driven pins are also recognized for uses involving cold-formed steel (CFS) framing, which are similar to the use of tapping screws. AC259 addresses requirements for justifying the transverse load capacity of power-driven fasteners used to attach gypsum board products to CFS wall framing. Power-driven fasteners used to construct shear walls comprised of wood structural panels fastened to CFS framing are evaluated under AC230. This criteria also includes requirements for establishing single-fastener connection capacities. Requirements for recognition of diaphragms comprised of wood structural panels fastened to CFS are provided in AC262. Together, AC230, AC259 and AC262 allow for broad recognition of power-driven fasteners used to attach sheathing materials to CFS framing.

## Tapping Screws

While power-driven fasteners are offered as alternates to tapping screws, the design of tapping screws continues to evolve. The tapping screws are evaluated under AC118, which provides manufacturers with an avenue for several different types of recognition. First, screws complying with all of the requirements of a code prescribed fastener standard, such as ASTM C 1513 or ASTM C 954, can be recognized as such. Secondly, if a screw design deviates from a prescribed standard, the design can be evaluated for use as an alternate to screws which comply with the prescribed standard. If a standard screw (or a recognized alternate) is intended for use in engineered connections, the shear and tension strengths of the screws must also be known. Since standards such as ASTM C 1513 do not go as far as establishing minimum screw strengths, ICC-ES ESRs recognize fastener shear and tension strengths based on independent laboratory testing. Using these strength values, connection capacities can then be determined in accordance with Section E4 of AISI S100 (referenced in IBC Section 2209.1). AC118 also allows for connection capacities to be justified based on testing in accordance with AISI S905.

One specialized use of a tapping screw that is already addressed in an ICC-ES Acceptance Criteria is that of constructing diaphragms consisting of wood structural panels attached to CFS framing. While the AISI S213 standard (referenced in IBC Section 2210.6) provides shear strength and deflection information for some of these diaphragms (those constructed with the screws prescribed in Table D2-1), manufacturers may wish to justify diaphragm capacities for other screw sizes or proprietary designs of screws. AC262 provides the requirements for this type of evaluation.

## Wood Screws

Long before screws were developed to join pieces of steel, they were used to join pieces

*Fastener Criteria Matrix*

| Main Member/ Substrate Material | Side Member/ Connected Element Material | Intended Use / Type of Evaluation | Fastener Type | | | |
|---|---|---|---|---|---|---|
| | | | Nails | Staples | Screws | Power-driven |
| Wood | Wood | Wood-to-wood connections | AC116 | AC201 | AC233 | |
| | | Corrosion resistance of fasteners used in treated wood | AC257 | AC257 | AC257 | |
| | | Diaphragms of wood structural panels attached to wood framing | | | AC120 | |
| | | Shear walls with wood structural panels attached to wood framing | | | AC120 | |
| | | Braced wall panels with wood structural panels attached to wood framing | | | AC120 | |
| Wood | Steel | Steel side plate-to-wood connections | AC116 | AC201 | AC233 | |
| Cold-Formed Steel (CFS) | Wood Structural Panels (WSP) | Connections of wood structural panel to CFS | | | AC118 | AC230 |
| | | Diaphragms of wood structural panels attached to CFS | | | AC262 | AC262 |
| | | Shear walls with wood structural panels attached to CFS | | | | AC230 |
| CFS | CFS | CFS-to-CFS connections | | | AC118 | |
| CFS | Gypsum board | Connections of gypsum board to CFS | | | AC118 | AC259 |
| Steel $t \geq 3/16$" | Various | Connections of building materials to structural steel | | | | AC70 |
| Steel | WSP | Diaphragms of wood structural panels attached to structural steel framing | | | | AC70 |
| Concrete | Various | Connections of building materials to concrete & concrete filled steel deck | | | | AC70 |
| Masonry | Various | Connections of building materials to masonry | | | | AC70 |

of wood together. As with many types of building products, the IBC and IRC address the most common type of wood screws, standardized in ANSI/ASME B18.6.1. However, many alternate screw designs are being developed to ease installation, to improve performance, and to address specialized connection needs, such as those needed for log construction. These alternate screw designs and applications are evaluated by ICC-ES in accordance with AC233. This criteria requires testing to determine reference lateral, pull-through and pullout capacities, as well as bending yield, tensile and shear strength of the fasteners. For screws which are expected to provide lateral capacity comparable to standard wood screws, the lateral connection capacities are calculated in accordance with the code, and confirmed by testing. For screws which are expected to perform better than the code-specified standard wood screws, lateral connection capacities may be justified directly by testing. To date, at least seven ESRs have been issued based on evaluations performed in accordance with ICC-ES AC233, providing reference connection values for more than twenty unique wood screw designs.

While wood screws have existed for a long time, use of wood screws to construct wood diaphragms and shear walls is not yet addressed by the building code. Manufacturers wishing to have their screws used in this manner must comply with the requirements of AC120 to justify substitution of the screws for the code-prescribed nails or to justify higher shear strengths.

## Nails

Nails may be the most prescribed type of fastener in the building code. Through a combination of references to AF&PA *National Design Specification for Wood* (NDS), the direct incorporation of shear wall and diaphragm load tables, and direct prescription of the number and size of nails needed for particular connections, the IRC and Chapter 23 of the IBC address the broad use of common nails. Nails are required to comply with ASTM F 1667. While a myriad of nail types is covered by this standard, not all nails on the market conform to the shank geometries and bending yield strength prescriptions of ASTM F 1667. The ICC-ES AC116 exists to help nail manufacturers demonstrate that their commodity nails comply with ASTM F 1667 and to provide an opportunity to justify the use of proprietary nail designs, or uses of nails not addressed by the NDS.

Visit the ICC-ES website, **www.icc-es.org** for more information.▪