A Strong Connection to HSS

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An upcoming design guide expands AISC's library of resources on HSS connections.

ENGINEERS THAT INCORPORATE hollow structural sections (HSS) into their designs—or that are thinking about doing so—will soon have another resource on the subject. AISC *Design Guide 24* (with a working title of "HSS Connections"), to be released soon, supplements the information on HSS connections in the AISC *Manual*. Add in the 2005 AISC *Specification*, and designers will have a trifecta of go-to manuals for information and recommendations on designing with HSS.

For starters, *Design Guide 24* discusses the ASTM properties of round and rectangular HSS, noting the differences that exist between the properties and yield strengths of the various shapes so that engineers will know which members to specify in any given situation (see Table 1).

The Guide also provides a discussion of some of the 2005 AISC *Specification* provisions for HSS design. For example:

1. Rectangular and square sections that exceed the periphery limit in ASTM A500 of 64 in. are classified as box-shaped members, and the section properties must be obtained from the manufacturer.
2. Information in Chapter K of the 2005 AISC *Specification*, which provides the design criteria for the various forces in the HSS members and framing systems, is illustrated.
3. The nominal wall thickness of HSS members is not the design thickness for HSS, due to manufacturing tolerances. The 2005 *Specification* and tables in the *Manual* and *Design Guide* provide for 0.93 times the nominal wall thickness for HSS. This reduction applies to electric resistance welded (ERW) manufactured shapes, but not submerged arc welded (SAW) HSS.

Also of note, the 2005 *Specification* incorporates both ASD and LRFD, and the design examples in *Design Guide 24* are calculated using both ASD and LRFD as well.

Consider Cost

For economical HSS construction, the designer must consider the cost of the connections. *Design Guide 24* explains the various types of connecting devices, including welding and mechanical fasteners. The AISC *Manual* provides design guidance and examples for simple shear connections; this information is not repeated in the *Design Guide*. Generally speaking, Figure 1 (page 55) shows some comparisons of more and less economical connections. Always consult a fabricator, though, as the right conclusion on economy often depends upon the specifics of the project!

Table 1. Round and Rectangular HSS and Pipe

Name	HSS Rectangular	HSS Square	HSS Round	Pipe
Designation	HSS6x5x¼	HSS5x5x¼	HSS5.563x0.258	P5,P5X,P5XX
Usual material	A500 Grade B[1]	A500 Grade B[1]	A500 Grade B[1]	A500 Grade B[2]
Min. yield strength	46 ksi	46 ksi	42 ksi	35 ksi
Max. wall thickness	⅝ in.	⅝ in.	⅝ in.	Not limited
Max. periphery dimension	64 in.	64 in.	64 in.	Not limited
Alternative hot-formed grades	A501[3] and A618[4]	A501[3] and A618[4]	A501[3] and A618[4]	N/A
Alternative weathering grades	A847	A847	A847	N/A

1. The Guide describes the ASTM specifications for HSS and notes that ASTM A500 Grade B is the typical and preferred HSS designation for cold-formed members with an electric resistance welded (ERW) continuous seam. ASTM A500 Grade C HSS, which has higher yield strength of 50ksi for rectangular/square and 46ksi for round HSS, is becoming increasingly more available but its availability should be confirmed prior to specifying Grade C products. It is important to check with the manufacturer or fabricator for the availability of certain shapes and sizes before designing and specifying HSS (see **www.aisc.org/availability** for HSS manufacturers and availability).
2. ASTM A53 products are available only in round cross-sections.
3. ASTM A500 (cold-formed) does not contain notch toughness requirements but ASTM A501 Grade B (hot-formed) does have these requirements.
4. ASTM A618 is the designation for hot-formed high-strength (yield strength of 50ksi) structural tubing. This specification is used in high strength low-alloy applications for square, rectangular, round and special shape tubing.

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Truss connections often involve directly welded HSS-to-HSS connections, and these are joints that can only be welded from one side. Economy requires that the designer consider this when selecting member wall thicknesses and specifying welds for these connections. Fillet welds are the most economical welds and should be used in HSS connections whenever possible. The *Design Guide 24* summarizes weld types that may be used in these joints and the limit states that must be considered by the designer. The 2005 *Specification* requires that both weld metal and base metal be checked for appropriate design limit states, and the new guide introduces the concepts of branch loads on HSS to determine connection nominal strength, including the principle limit states that apply. Several of these are illustrated for a rectangular HSS gapped K-connection, as illustrated in Figure 2.

Several types of mechanical fasteners used for HSS connections are listed in the new guide, and design examples are provided to illustrate design principles as outlined in the *Specification* for fasteners. These fasteners typically include:

- Through-bolts
- Threaded studs
- Flow-drilled bolts
- Screws
- Blind bolts
- Nails

Fasteners are generally categorized as subjected to shear or tension loading (although a combination of both can occur). Some specialty products exist for these applications, including Lindapter Hollo Bolt fasteners shown in Figures 3 and 4.

Another proprietary connection product available for HSS applications, bracing connections in this case, is the Cast ConneX High-Strength Connector, shown in Figures 5 and 6.

For more information on the Lindapter (**www.lindapter.com**) and Cast ConneX (**www.castconnex.com**) products, as well as other HSS connection products, please contact our Steel Solutions Center at **solutions@aisc.org**.

End Plates

The new design guide also discusses moment connections and tension/compression connections, including end-plate design. For moment connections, it lists types of connections and design examples for connections between W-shape beams and HSS columns in several configurations: continuous beams over HSS columns, through-plate

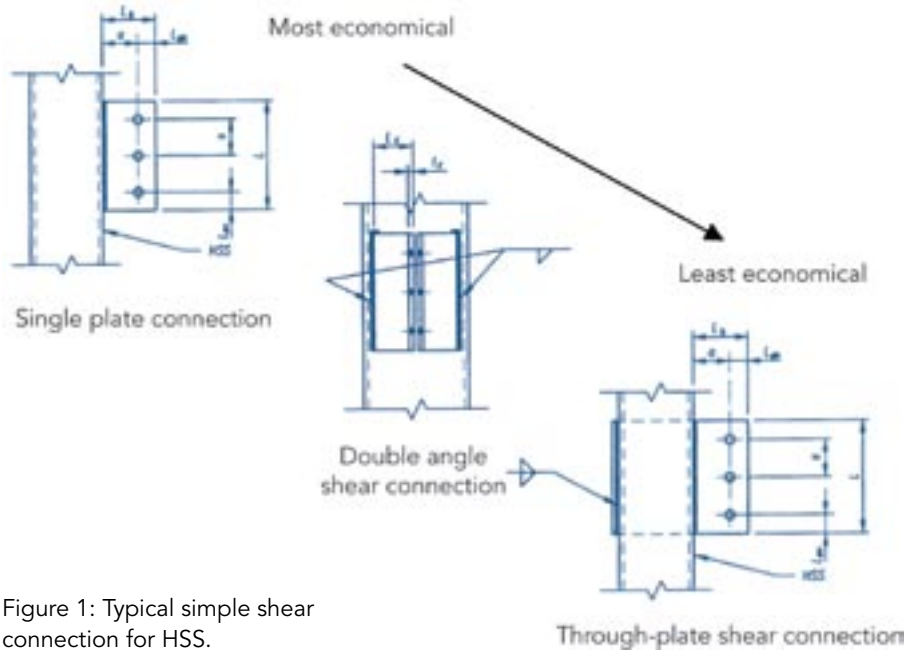


Figure 1: Typical simple shear connection for HSS.

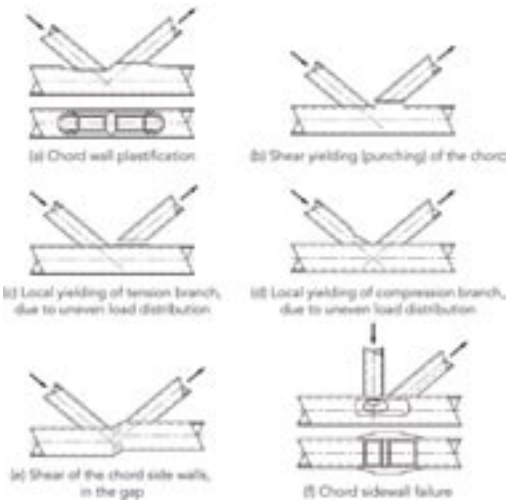
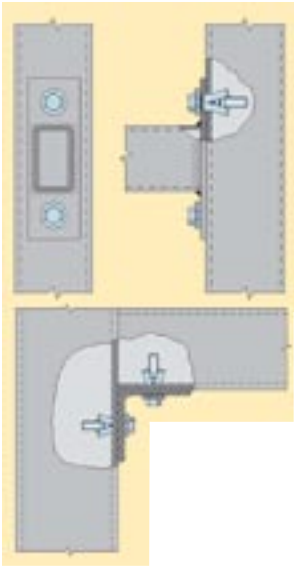


Figure 2: Typical limit states for HSS-to-HSS truss connections.

connections, and directly welded connections. It provides guidance for consideration of the effect of line loads and concentrated forces on the walls of HSS; HSS frequently are used as bracing components in bracing systems that are subject to tension and compression loads. In addition, the guide covers topics pertaining to end-tee, slotted-gusset, and end-plate connections with design examples provided. Figure 7 shows typical connection details for HSS.

In the coming months, check **www.aisc.org** for an announcement on when AISC *Design Guide 24* will be released (when it is, it'll be a free download at **www.aisc.org/epubs** for AISC members). And while you're at the AISC web site, take a look at **www.aisc.org/hss** for additional HSS resources. And again, you can always contact AISC's Steel Solutions Center via 866. ASK.AISC or **solutions@aisc.org**. MSC



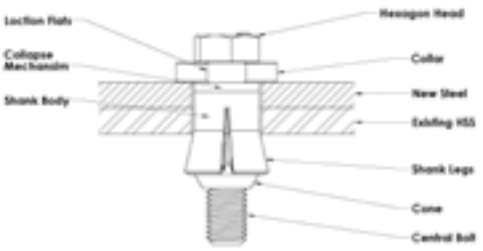


Figure 3: Hollo Bolt connection details.

Figures 3 and 4 courtesy Lindapter

Figure 4: Picture of Hollo Bolt connection details.

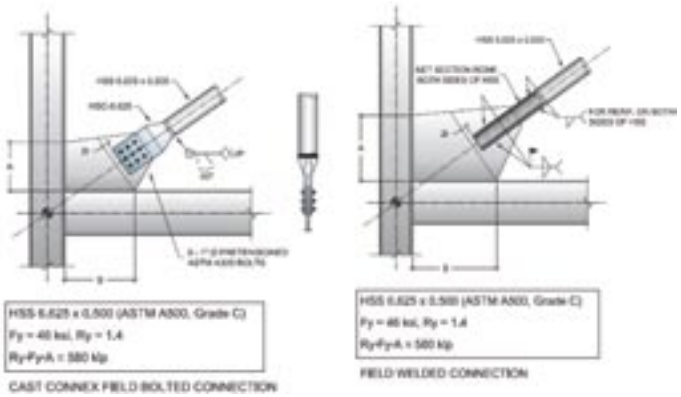


Figure 5: Comparison of Brace Detail.

Figure 6: Installed Cast ConneX brace.

Figures 5 and 6 courtesy Cast ConneX

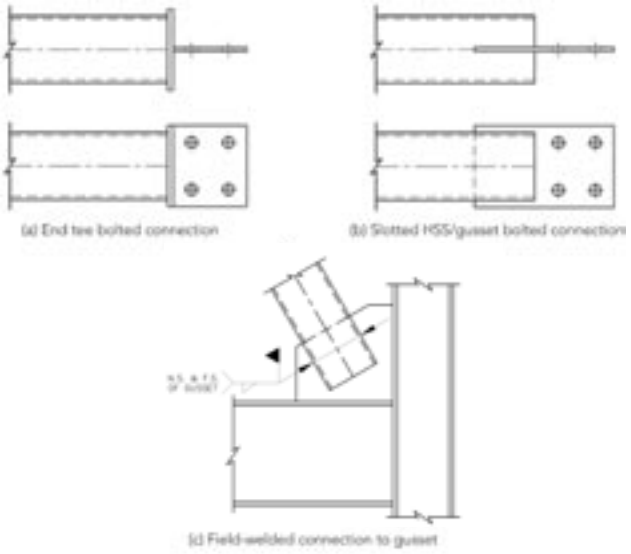


Figure 7: Bracing connections with bolts or welds in shear.

More on HSS

Experimental and theoretical studies conducted on HSS members and their connections since the 1970s form the basis for many of the current HSS requirements. CIDET (International Association for the Development and Study of Tubular Construction) offers HSS design guides to promote the use of HSS members.

In addition, the 1997 AISC *Specification for the Design of Steel Hollow Structural Sections* and the AISC *HSS Connections Manual* sparked significant growth in the use of HSS in building construction in the United States. Current requirements for the use of HSS in building design and construction have been integrated into ANSI/AISC 360-05 *Specification for Structural Steel Buildings* (the AISC *Specification*), which is available for free download at **www.aisc.org/freepubs**. The 13th Edition AISC *Steel Construction Manual* contains guidance and design aides for use in the design of HSS members and connections.