

## HSS Connections

By Leigh Arber and Erika Winters-Downey, S.E., LEED AP

“Although HSS have been used in structures throughout the world, some designers and fabricators are still reluctant to use HSS because of unfamiliarity and concerns regarding connections,” says Don Sherman, professor emeritus at the University of Wisconsin-Milwaukee, who has been involved with research and design of HSS for many years.

Hollow structural sections (HSS) are often used because of their elegant appearance as architecturally exposed members.

HSS are also strong in torsion and compression, and beneficial because of their reduced surface area and weight compared with open sections. However, connections between HSS can be a challenge. The complex, unusual configurations of connections can pose geometry and access problems for fabricators, and reinforcement such as stiffener plates may be impossible to include on closed sections.

Chapter K of the 2005 AISC *Specification for Structural Steel Buildings* addresses the design of HSS and box member connections. The chapter covers concentrated forces on HSS, HSS-to-HSS truss connections, and HSS-to-HSS moment connections. The commentary to Chapter K describes the limit states in greater detail, and also cites important studies carried out by the International Committee for the Development and Study of Tubular Construction (CIDECT).

AISC *Design Guide 24: Hollow Structural Section Connections*, written by Dr. Jeffrey Packer, Dr. Donald Sherman, and Dr. Maura Lecce, will be available in the summer of 2010. The design guide is based on the 2005 AISC *Specification for Structural Steel Buildings* and presents detailed information about HSS connections, including mechanical fasteners, methods of welding, and critical concerns such as notch toughness and internal corrosion. Practical design problems show, for example, calculations



of required weld sizes and lengths, through-bolt strength, W-shape to HSS moment connections, and many other types of connections and configurations. The design guide presents general tips and guidelines, such as the appropriate slenderness ratios for main and branch members, to help engineers make good design choices that facilitate HSS connections. Explanations and photographs of the applicable limit states, including chord pastification and punching shear, help illuminate the possible failure modes.

Because of the complex three-dimensional geometry, proprietary and custom connections may be used in HSS connections. More of these connections are used in Europe and Asia, where HSS represent about 30% of all steel construction, approximately double the market share they represent in the U.S. Cast Connex Corporation is an example of a North American company that manufactures several types of cast pin connectors. Their Universal Pin Connectors™ are clevis-type connectors especially suited for round HSS elements in architecturally exposed applications. These connectors, used in the Air National Guard Operations and Training Facility in New Jersey at the ends of 12.750-inch diameter HSS columns, are shown in *Figure 1*. Cast pin connections are an aesthetically attractive alternative to the traditional slotted HSS-to-gusset plate connection. The castings are attached to the HSS members in the fabrication shop, eliminating the need for expensive and labor-intensive field welding.

AISC continues to encourage research on HSS for designing members and connections. The AISC Faculty Fellowship, an annual program that provides research funding to a promising university faculty member for four years, has recently been awarded to Professor Jason McCormick of the University of Michigan. Professor McCormick will study and develop the use of HSS connections in high seismic zones, including HSS connections in intermediate moment frames (IMF) and special moment frames (SMF). Unlike most prior research on HSS connections, Professor McCormick's study will investigate connections in which both the column and beam are HSS or concrete-filled tube (CFT) sections. HSS-to-HSS, CFT-to-HSS, and CFT-to-CFT connections will be studied, modeled and tested and, with industry input, the most viable



*Figure 1: Cast Connex® Universal Pin Connectors™ used in the Air National Guard Operations and Training Facility, New Jersey. Courtesy of Carlos de Oliveira, Cast Connex Corporation.*

connection configurations for each will be identified. Other goals of the research are: to establish limits for the development of plastic hinges with adequate ductility, to understand the limit states relevant to flexural deformation in CFT beam sections, and to provide detailed design guidelines for HSS and CFT moment connections, including parameters such as weld/bolt details, continuity plates, and optimal configurations.

HSS continue to be an attractive choice because of their structural properties and aesthetic appeal. The forthcoming AISC Design Guide 24, ongoing research in the industry, and the availability of proprietary connections can help designers make wise decisions about HSS connections. ■

*Leigh Arber is a structural engineer with the American Institute of Steel Construction in Chicago. She works on the development of new design guides, and acts as secretary to the technical committees which develop the Seismic Provisions for Structural Steel Buildings and the Seismic Design Manual.*

*Erika Winters Downey, S.E., LEED AP, is the Great Plains Regional Engineer for AISC. Erika helps assess the viability of structural steel framing options on upcoming projects. She is also an educational resource on technical and economic aspects of building with structural steel. Erika can be contacted at [wintersdowney@aisc.org](mailto:wintersdowney@aisc.org).*