Hollow structural sections (HSS) make up a significant portion of the steel market, where the typical uses in building structures are as column members, bracing members, exposed structural steel, cladding supports, concrete filled tube sections, and truss members. Recent seismic steel research focused on improvements to wide-flange seismic moment resisting frame (SMRF) systems. HSS members provide a possible means of improving the performance of SMRF systems in low- to mid-rise structures based on their high strength-to-weight ratio, good compression and bending properties, and high torsional stiffness. However, an understanding of the behavior of HSS under cyclic bending loads is required along with detailing requirements of HSS-to-HSS moment connections to ensure proper ductility and strength is achieved.

An experimental and analytical program is undertaken to characterize the ability of HSS beam members to withstand large plastic rotations with minor degradation of the maximum moment capacity. Experimental testing of eleven full-scale HSS beam members is carried out. These experimental results are used to calibrate a finite element model for analysis of 133 different beam members. The models account for section geometry, material properties, and local buckling. Local buckling limits the ability of these members to form stable plastic hinges and the behavior is highly dependent on the width-thickness (b/t) and the depth-thickness ratio (h/t).

With an understanding of the limiting b/t and h/t ratios for HSS beam members, a connection design methodology is derived for both unreinforced and reinforced fully welded HSS-to-HSS moment connections. A finite element model parametric study is undertaken to better understand the effect of different parameters on the connection performance under cyclic loads typical of an earthquake. Experimental testing of two unreinforced HSS-to-HSS connections with unmatched and matched beam and column widths are also cyclically tested to failure. The hysteretic behavior shows that these connections are limited in their ability to isolate inelastic behavior in the beam member and panel zone region and suggest that unreinforced HSS-to-HSS moment connections cannot achieve a strong column-weak beam mechanism. Based on the finite element model and the experimental study results, recommendations are provided for the design of HSS-to-HSS seismic moment connections.