Introduction to the AISC *Seismic Provisions*

The 2005 *Seismic Provisions*

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A MAJOR CHANGE TO AISC'S 2005 *SEISMIC PROVISIONS FOR STRUCTURAL STEEL BUILDINGS*, INCLUDING SUPPLEMENT NUMBER 1

sions, exceptions to the 2005 specification and additional criteria are specified.)

Part I: Structural Steel Buildings

The first four sections of Part I establish the provisions' relationship with the 2005 specification, as well as with the applicable building code and other applicable national standards such as ASCE and ASTM, among others.

Section Overviews

Section 1—Scope: Section 1 defines the scope of the 2005 provisions: they apply to buildings classified by the applicable building code as seismic design category D or more severe. In seismic design categories A, B, and C, which are less severe, the system must satisfy one of two conditions: a seismic response modification coefficient, *R* of 3, must be used and elements must be designed to satisfy the 2005 specification only; or a higher *R* value must be used and the system must be designed to meet all of the requirements of the 2005 provisions. The second requirement is to ensure that large *R*-values are not being used for a structure without meeting the ductility detailing requirements of the 2005 provisions.

Sections 2-4—Applicable Codes and Standards: Section 2 lists referenced standards beyond those given in the 2005 specification. Sections 3 and 4 direct the user to the applicable building code for determining the required strength, where the applicable building code is defined as the "building code under which the structure is designed."

Section 5—Construction Documents: The newly developed Section 5 outlines information required in the construction documents prepared by the engineers, fabricators, and erectors. Design drawings and specifications must identify all elements of the seismic load resisting system (SLRS), demand critical welds, protected zones, connection configuration, welding requirements, etc. Shop drawings and erection drawings must include similar information to verify that the fabricator and erector understand the design intent.

Section 6—Material Properties and Characteristics: Section 6 considers acceptable material properties and characteristics for structural

F_yR_y results in the expected yield strength of the material. A second term, R_t, has been introduced. When R_t is multiplied by the nominal tensile strength, F_u, the result is the expected tensile strength of the material. The remainder of the provisions identifies when the R_y and R_t terms are to be used in determining the required strength of the members.

Section 7—Design of Connections, Joints, and Fasteners: The design of connections, joints, and fasteners in the SLRS is addressed in Section 7. All connections should be detailed so that a ductile limit state controls the strength of the components. It also defines the "protected zone," or the critical regions of elements in the [illegible] avoided to minimize the chance of premature brittle [illegible] of the members.

All bolted connections must use [illegible]ed high-strength bolts, with the faying [illegible] pared for Class A or better slip [illegible] However, bolted connections may be designed for the strength in bearing. This requirement is meant to avoid joint slip during small earthquakes, while recognizing that bolts will eventu-

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ally develop bearing during a design-level seismic event. Standard holes are required at bolted joints; short-slotted holes are acceptable when the axis is perpendicular to the direction of load. Oversized holes also may be used if they are in only one ply of the slip-critical joint. Bolts and welds are not allowed to share load at the same joint.

Welded connections must be made with filler metals that have a minimum CVN toughness of 20 ft-lbs at 0 ºF. This is a relaxation from the previously adopted temperature of -20 ºF. Demand critical welds still require filler metal with a minimum CVN toughness of 20 ft-lbs at -20 ºF. An additional requirement of 40 ft-lbs at 70 ºF CVN toughness is placed on demand critical complete-joint-penetration groove welds in various systems (for example: welds of beam flanges to columns, column splice joints, and welds of beam webs to column flanges). Specific detailing requirements for continuity plates are also provided in this section.

Section 8—Local and Global Instabilities: Requirements for local and global instabilities, as well as other general member requirements, are considered in Section 8. The limiting width-to-thickness ratios of flanges and webs for members in the SLRS are provided. These ratios are more restrictive than the compact section ratios given in the 2005 specification because of the expected inelastic demand during seismic behavior. The remaining portion of this section emphasizes column design. Splices for columns that are not part of the SLRS now have special design requirements since research indicates these columns may have significant flexure and shear demand during a severe seismic event.

Sections 9 through 17 provide design requirements for each of the codified structural steel building systems:

Section 9—Special Moment Frames (SMFs): SMFs are considered highly ductile and therefore have the highest *R* factor of the steel buildings systems discussed here. The proposed use of a particular moment-resisting joint must have a demonstrated capability of accommodating an interstory drift of 0.04 radians. This is accomplished by one of the following:

- Using a connection prequalified for use in a SMF in accordance with *Prequalified Connections for Special and Intermediate Moment Frames for Seismic Apoy f*

strength in the web of the steel plate shear wall.

Similar to plate girder behavior, tension field action develops as the relatively thin web buckles during lateral loading. Limitations on configuration, width-thickness ratios, and other design parameters are provided to be consistent with the successful test results.

Section 18—Quality Assurance: Section 18, the final section of Part I, addresses a comprehensive quality assurance plan that is required to demonstrate that the structural design intent is accomplished during construction. Newly developed Appendix Q discusses requirements related to quality assurances and quality control to be provided by the contractor. Inspection requirements, both visual and non-destructive evaluation (NDE) inspections, for welds are presented in tabular form. A similar table for bolted connections is also provided.

Part II: Composite Structural Steel and Reinforced Concrete Buildings

Part II of the *Seismic Provisions* considers the design of composite systems of structural steel and reinforced concrete. This part contains individual sections governing design requirements for beams composite with concrete slabs, composite columns, and the design of connections between concrete and steel elements. (A cross-reference with ACI 318 is an important new feature.)

Composite connections have been designed using the basic principles of mechanics, existing standards for steel and concrete construction, test data, and engineering judgment. The connection section is intended to standardize and improve design practices by establishing basic behavioral assumptions for developing design models that satisfy equilibrium of internal forces in the seismic design connection.

The remaining sections of Part II address the design of various composite structural system types. These sections parallel those found in Part I and generally have *R* factors and system application limitations similar to the comparable structural steel systems. In addition to the composite SMF, IMF, and OMF system requirements, there is a composite partially restrained moment frame (C-PRMF) system having connection details similar to those shown in Figure 2.

Similar to Part I, there are two concentrically braced composite systems and one eccentrically braced composite system addressed in Part II. Part II also identifies three composite systems that use wall elements as the primary component in the SLRS. Two types of composite walls, one special and one ordinary, parallel the reinforced concrete wall specifications of ACI 318; however, structural steel elements are used in the boundary elements (as shown in Figure 3). Finally, a composite steel plate shear wall system is also codified.

More information may be found in the paper "The 2005 AISC *Seismic Provisions for Structural Steel Buildings*," published in the 2005 North American Steel Construction Conference Proceedings, available for AISC members to download free at **www.aisc.org**.

The 2005 *Seismic Provisions for Structural Steel Buildings, Including Supplement Number 1* is available to download free from AISC's web site at **www.aisc.org**. It is also available in print at **www.aisc.org/bookstore**. This document has been adopted by reference in the 2006 *International Building Code*