

Part I

2. PRODUCTS

2.1 Structural Steel

Structural steel, of the strength and grade shown on the design drawings shall conform to the requirements of the following ASTM standards, as applicable.

- (a) A36 – *Specification for Carbon Structural Steel*
- (b) A572 – *Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel*
- (c) A913 – *Specification for High-Strength Low-Alloy Steel Shapes of Structural Quality, Produced by Quenching and Self-Tempering Process*
- (d) A992 – *Standard Specification for Steel for Structural Shapes for Use in Building Framing*

Commentary: Project specifications should list only those material specifications that are actually intended to be incorporated on the project. Those specifications that are not applicable to a specific project should be deleted. It is recommended that structural shapes used in new steel moment-frame seismic-force-resisting systems conform either to ASTM 913, or ASTM 992. Refer to FEMA-350 for additional information on appropriate material specifications for various applications.

2.1.1 Supplemental Requirements for Structural Steel

2.1.1.1 Wide-Flange Structural Sections

All wide-flange steel members comprising the Seismic-Force-Resisting System shall conform to ASTM A992 or ASTM A913. Shapes of ASTM A572, grade 50, mill-certified to AISC Technical Bulletin No. 3 requirements, may be substituted for A992 with the Engineer's approval. Shapes of ASTM A913, grade 50, shall satisfy ASTM Supplementary Requirement S75.

2.1.1.2 Heavy Sections

Heavy Sections, as defined in Section 1.3.15, shall be supplied with Charpy V-notch (CVN) testing in accordance with ASTM A6, *Supplementary Requirement S5*. The test shall meet a minimum average absorbed energy value of 20 ft-lbf at +70°F. Testing shall be in accordance with the current *AISC Specification*.

All Heavy Section column flanges located at welded moment connections shall be ultrasonically examined, prior to welding, for evidence of laminations, inclusions, or other discontinuities in accordance with ASTM A435, *Straight Beam Ultrasonic Examination of Steel Plates*, or ASTM A898, *Straight Beam Ultrasonic Examination of Rolled Steel Structural Shapes*, as applicable. The area to be tested is a zone 3 in. above and below each beam flange connection. For plates, any discontinuity causing a total loss of back reflection that cannot be

contained within a circle the diameter of which is 3 inches, or one-half the plate thickness, whichever is greater, shall be rejected. For shapes, ASTM 898 Level I criteria are applicable.

If beams in the Seismic-Force-Resisting System are moment-connected to the weak axis of columns, the column web shall be similarly examined to the above criteria, if greater than 2 inches thick.

Commentary: This requirement is applicable to structural steel in building applications that are normally enclosed and heated. For applications in cold regions, where structural steel will be exposed to low service temperatures, supplemental toughness requirements may be appropriate. Additional information on these toughness requirements may be found in the Commentary to Section A.3C of the AISC LRFD Specifications.

2.2 Fasteners

Fasteners shall conform to the requirements of the following ASTM standards, as applicable, for the strength, grade and type shown on the design drawings:

- (a) A325 – *Specification for Structural Bolts, Steel, Heat-Treated, 120/105 ksi Minimum Tensile Strength*
- (b) A490 – *Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength*
- (c) A563 – *Specification for Carbon and Alloy Steel Nuts*
- (d) F436 – *Specification for Hardened Steel Washers*
- (e) F959 – *Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners*
- (f) F1852 – *Specification for “Twist-Off” Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength*

Commentary: Bolts connecting structural steel components of the Seismic-Force-Resisting System should normally conform to ASTM A325, ASTM A490, or ASTM F1852 pretensioned as for slip-critical applications. Other bolt materials may be used for connection of other components of the steel structure or for connection of the Seismic-Force-Resisting System to the foundation. See also Section 3.2.2.

2.3 Anchor Rods

Anchor rods shall conform to the requirements of the following ASTM standard:

- (a) F1554 - *Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength*

Other material may be used for anchor rods as permitted by current AISC Specifications.

2.4 Welding Material

Welding materials shall conform to the following AWS specifications, as applicable:

- (a) ANSI/AWS A5.1-91, *Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding*
- (b) ANSI/AWS A5.5-96, *Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding*
- (c) ANSI/AWS A5.17/A5.17M-97, *Specification for Carbon Steel Electrodes and Fluxes for Submerged Arc Welding*
- (d) ANSI/AWS A5.18-93, *Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding*
- (e) ANSI/AWS A5.20-95, *Specification for Carbon Steel Electrodes for Flux-Cored Arc Welding*
- (f) ANSI/AWS A5.23/A5.23M-97, *Specification for Low-Alloy Steel Electrodes and Fluxes for Submerged Arc Welding*
- (g) ANSI/AWS A5.25/A5.25M-97, *Specification for Carbon and Low-Alloy Steel Electrodes and Fluxes for Electroslag Welding*
- (h) ANSI/AWS A5.26/A5.26M-97, *Specification for Carbon and Low-Alloy Steel Electrodes for Electrogas Welding*
- (i) ANSI/AWS A5.28-96, *Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding*
- (j) ANSI/AWS A5.29-98, *Specification for Low-Alloy Steel Electrodes for Flux-Cored Arc Welding*
- (k) ANSI/AWS A5.32/A5.32M-97, *Specification for Welding Shielding Gases*

2.4.1 Supplemental Requirements for Welding Materials

2.4.1.1 Toughness, Strength and Elongation

All welds on members comprising the Seismic-Force-Resisting System, except as noted below for joining of material conforming to ASTM A913, grade 65, shall employ weld filler metals classified for nominal 70 ksi tensile strength, referred to as E70 electrodes, meeting the following minimum mechanical property requirements:

1. CVN toughness of 20 ft-lb at 0°F, using AWS A5 classification test methods
2. CVN toughness: 40 ft-lb at 70°F, using the test procedures prescribed in Appendix A

3. yield strength: 58 ksi minimum, using both the AWS A5 classification test (for E70 classification electrodes) and the test procedures prescribed in Appendix A
4. tensile strength: 70 ksi minimum, using both the AWS A5 classification test (for E70 classification electrodes) and the test procedures prescribed in Appendix A
5. elongation: 22% minimum, using both the AWS A5 classification test and the test procedures prescribed in Appendix A.

Welded joints of ASTM A913, grade 65 material shall be made with weld filler metals classified as E80 electrodes with a minimum yield strength of 68 ksi, minimum tensile strength of 80 ksi, and a minimum elongation of 19%. CVN toughness requirements of (1) and (2) above shall apply.

Commentary: For applications where the Seismic-Force-Resisting System is subjected to service temperatures below 50°F following completion of the construction, the CVN toughness requirement for item (2) above should be conducted at a test temperature not less than 20°F above the lowest anticipated service temperature.

For all other joints, welding materials shall meet the requirements of the designated A5 classification test. A minimum CVN toughness is not required, except for the specific joints and designs described in Table 2.3 in the AISC LRFD Specification for Structural Steel Buildings dated December, 1999.

2.4.1.2 Hydrogen Level

For welded joints designated as Seismic Weld Demand Category A or B, welding filler metals, as supplied by the manufacturer, shall meet the requirements for H16 (16 ml diffusible hydrogen per 100 grams deposited weld metal) as tested using the mercury or gas chromatograph method as specified in AWS A4.3, *Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding*. The manufacturer's Certificate of Conformance shall be considered adequate proof that the supplied electrodes meet this requirement, and no additional testing of filler metal samples or of production welds is required.

For all other welds on members of the Seismic-Force-Resisting System, the weld filler metals shall be considered classified as low-hydrogen under the provisions of AWS D1.1.

Commentary: All electrodes and fluxes for FCAW, GMAW, SAW, GTAW, ESW and EGW processes are considered low-hydrogen. For SMAW, electrodes listed in AWS Table 3.1 for steels in Group II or higher are considered low-hydrogen.

2.4.1.3 Packaging Requirements

Packaging of weld filler metals shall conform to the requirements of AWS D.1.1. FCAW electrodes shall be received in moisture-resistant packages that are undamaged. They shall be protected against contamination and injury during shipment and storage. Electrode packages shall

remain effectively sealed against moisture until the electrode is required for use. When removed from protective packaging and installed on machines, care shall be taken to protect the electrodes and coatings, if present, from deterioration or damage. Modification or lubrication of an electrode after manufacture for any reason is not permitted, except that drying shall be permitted when recommended by the manufacturer.

2.5 Shear Connectors (Shear Studs)

Stud Shear Connectors shall be *AWS D1.1* “Type B” headed studs made from *ASTM A108*, Grade 1015 or 1020, cold-finished carbon steel, with dimensions complying with *AWS D1.1* for the type and sizes shown.