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Structural Welding Code— Steel



American Welding Society



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Structural Welding Code— Steel

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Prepared by the
American Welding Society (AWS) D1 Committee on Structural Welding

Under the Direction of the
AWS Technical Activities Committee

Approved by the
AWS Board of Directors

Abstract

This code covers the welding requirements for any type of welded structure made from the commonly used carbon and low-alloy constructional steels. Clauses 1 through 8 constitute a body of rules for the regulation of welding in steel construction. There are eight normative and twelve informative annexes in this code. A Commentary of the code is included with the document.



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Foreword

This foreword is not part of AWS D1.1/D1.1M:2008, *Structural Welding Code—Steel*, but is included for informational purposes only.

The first edition of the *Code for Fusion Welding and Gas Cutting in Building Construction* was published by the American Welding Society in 1928. The first bridge welding specification was published separately in 1936. The two documents were consolidated in 1972 into the D1.1 document but were once again separated in 1988 when the joint AASHTO/AWS D1.5, *Bridge Welding Code*, was published to address the specific requirements of State and Federal Transportation Departments. Coincident with this, the D1.1 code changed references of buildings and bridges to statically loaded and dynamically loaded structures, respectively, in order to make the document applicable to a broader range of structural configurations.

Underlined text in the subclauses, tables, or figures indicates an editorial or technical change from the 2006 edition. A vertical line in the margin indicates a revision from the 2006 edition.

The following is a summary of the most significant technical revisions contained in D1.1/D1.1M:2008:

Clause 1.2—Revised to clarify limitations of the code.

Clause 2.3.5—New section on depth of filling for plug and slot welds added.

Clause 2.5.4—Revisions made to clarify the allowable stress for a singular linear fillet weld or fillet weld groups of parallel linear fillet welds.

Clause 2.5.4.4—Adds design equation for determining allowable stresses on fillet welds in concentrically loaded weld groups.

Clause 2.6.7—Revised provision for calculating the resistance provided by connections sharing the load between welds, bolts, and rivets.

Clause 2.7.1—Revised to eliminate transition slope requirements for butt joints of unequal thickness in typical low yield tension load situations.

Clause 2, Tables—Tables 2.4 through 2.9 were renumbered to accommodate a new table detailing the strength coefficients for obliquely loaded fillet welds.

Table 2.3—New note added to limit allowable stresses for plug and slot welds.

Figure 2.2—Revised to apply to cyclically loaded structures.

Figure 2.3—Revised to apply to the thickness of statically loaded structures.

Figure 2.6—Corrections made to better illustrate holdback dimensions and tension.

Figures 2.9 and 2.10—Corrections were made to splice joint thicknesses.

Clause 3.7—Adds new provision on prequalified shielding gases.

Clause 3.10—Revised to clarify the minimum depth of filling for plug and slot welds.

Figure 3.4—Correction made was to the tolerances for B-U7-S.

Clause 4.8.1—Term “run-off tab” replaced with “weld tabs.”

Clauses 4.11.1 and 4.11.2—Qualification testing requirements for fillets clarified.

Clause 4.23.2—Revised to clarify welding operator requirements for ESW and EGW.

Table 4.1—Note assignments for production pipe butt-grooves clarified.

Table 4.5—Revised so that number of electrodes is a PQR essential variable for GTAW.

Table 4.6—Changes were made to required PQR supplementary essential variables when for single to multiple electrode, or vice versa, in same weld pool and interpass temperatures.

Table 4.10—Note assignments clarified.

Figure 4.19—1/8 in [3 mm] weld size added to fillet weld soundness tests for WPS qualification.

Figures 4.31 and 4.32—Note added to allow side-bent test substitutions for face- or- root-bend tests for 3/8 in [10 mm] plate.

Figure 4.38—Revised to apply to both welder and welder operator qualification as well as WPS qualification.

Clause 5.3—Deleted references to shielding gases.

Clauses 5.3.4.1 and 5.3.4.2—Revised to clarify low-alloy electrodes by strength and not process. References to A5 specifications corrected.

Clause 5.18—Entire section on temporary welds and tack welds was revised and reorganized while introducing the new term “construction aid welds.”

Clause 5.22.1—Changed “fillet weld leg” to “fillet weld legs” for clarification.

Clause 6.1.4.4—Changed the required visual acuity test from Snellen English test to a Jaeger J-2 test at a distance of 12 in–17 in [300 mm–430 mm].

Clause 6.12—Entire section RT discontinuity acceptance criteria was reorganized.

Clause 6.24.1—Changed the required minimum requalification interval for UT equipment horizontal linearity.

Clause 6.25.3—Changed the recalibration interval requirement for UT testing equipment.

Clause 6.25.5.2—Revised to establish the required maximized horizontal trace deflection screen height for IT testing procedures.

Clause 6, Figures—All figures and cases in Clause 6 have been revised and renumbered.

Figures 6.2 and 6.3—Figure on maximum acceptable RT images was moved to the commentary.

Clause 7.2.6—Correction made to ASTM specification reference.

Clause 7.3.3—Revised to eliminate six-month requirement for quality control tests on studs prior to delivery.

Clause 7.8.5—Revised to clarify the Contractor’s responsibility for corrective stud welding.

Annex C—Content was moved to Clause 6 Commentary. Annex C left blank to avoid confusion with Commentary sections.

Annex G—Contents moved into Clause 7 as new Clause 7.9. Text revised so a stud base qualified with an approved grade of ASTM A 108 also meets requirements of 7.3.1.

Annex K—Added new term “construction aid weld” and deleted term “temporary weld.”

Annex N—Sample form N-1 revised to include power source.

Annex U—Reference documents have been updated to include applicable year.

Annex V—Updated all tables to include most recent A5 Classifications.

Clause C-1.2—Content deleted and moved into Clause 1.2.

Clauses C-2.5.4, C-2.6.5, C-2.6.7, and C-2.7.1—New commentary added.

Clause C-2, Figures—Figures renumbered and new figures added illustrating obliquely loaded weld groups.

C-Table 3.7—New commentary added for root pass and fill pass thickness variables.

Clause C-5.3.2.1—Revised to clarify “low-hydrogen” term.

Clause C-6.11.1—New commentary added on tubular connection requirements.

Clause C-6, Figures—New figures added illustrating discontinuity acceptance criteria.

Clause C-Annex I—Section designations removed for clarification.

AWS B4.0, *Standard Methods for Mechanical Testing of Welds*, provides additional details of test specimen preparation and details of test fixture construction.

Commentary. The Commentary is nonmandatory and is intended only to provide insightful information into provision rationale.

Normative Annexes. These annexes address specific subjects in the code and their requirements are mandatory requirements that supplement the code provisions.

Informative Annexes. These annexes are not code requirements but are provided to clarify code provisions by showing examples, providing information, or suggesting alternative good practices.

Index. As in previous codes, the entries in the Index are referred to by subclause number rather than by page number. This should enable the user of the Index to locate a particular item of interest in minimum time.

Errata. It is the Structural Welding Committee's Policy that all errata should be made available to users of the code. Therefore, any significant errata will be published in the Society News Section of the *Welding Journal* and posted on the AWS web site at: <http://www.aws.org/technical/d1/>.

Suggestions. Your comments for improving AWS D1.1/D1.1M:2008, *Structural Welding Code—Steel* are welcome. Submit comments to the Managing Director, Technical Services Division, American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126; telephone (305) 443-9353; fax (305) 443-5951; e-mail info@aws.org; or via the AWS web site <<http://www.aws.org>>.

Errata

The following Errata have been identified and incorporated into the current reprint of this document.

Page 67—Table 3.1, Filler Metal Requirements—Remove dash from “E9018-M” under Electrode Classification column from Group IV so it reads E9018M.

Page 105—Figure 3.4, Joint Designation C-U2a-GF—Under “Notes” column, Note 1 should read Note a.

Pages 136–153—Header—Change from “Clause 4. Prequalification” to “Clause 4. Qualification” on all the designated pages.

Page 146—Table 4.9, Filler Metal Requirements—Remove dash from “E11018-M” in the Electrode Classification column under “Matching Strength Filler Metal” so it reads E11018M.

Page 150—Table 4.11, Welder and Welding Operator Qualification—Number and Type of Specimens and Range of Thickness and Diameter Qualified (Dimensions in Millimeters)—For Production Fillet Welds (T-joint and Skewed), under “Number of Specimens” column for side bend tests, Note 3 should read Note c.

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Structural Welding Code—Steel

1. General Requirements

1.1 Scope

This code contains the requirements for fabricating and erecting welded steel structures. When this code is stipulated in contract documents, conformance with all provisions of the code shall be required, except for those provisions that the Engineer (see 1.4.1) or contract documents specifically modifies or exempts.

The following is a summary of the code clauses:

1. General Requirements. This clause contains basic information on the scope and limitations of the code, key definitions, and the major responsibilities of the parties involved with steel fabrication.

2. Design of Welded Connections. This clause contains requirements for the design of welded connections composed of tubular, or nontubular, product form members.

3. Prequalification. This clause contains the requirements for exempting a WPS (Welding Procedure Specification) from the WPS qualification requirements of this code.

4. Qualification. This clause contains the requirements for WPS qualification and the qualification tests required to be passed by all welding personnel (welders, welding operators, and tack welders) to perform welding in accordance with this code.

5. Fabrication. This clause contains general fabrication and erection requirements applicable to welded steel structures governed by this code, including the requirements for base metals, welding consumables, welding technique, welded details, material preparation and assembly, workmanship, weld repair, and other requirements.

6. Inspection. This clause contains criteria for the qualifications and responsibilities of inspectors, acceptance criteria for production welds, and standard procedures for performing visual inspection and NDT (nondestructive testing).

7. Stud Welding. This clause contains the requirement for the welding of studs to structural steel.

8. Strengthening and Repair of Existing Structures. This clause contains basic information pertinent to the welded modification or repair of existing steel structures.

1.2 Limitations

The code was specifically developed for welded steel structures that utilize carbon or low alloy steels that are 1/8 in [3 mm] or thicker with a minimum specified yield strength of 100 ksi [690 MPa] or less. The code may be suitable to govern structural fabrications outside the scope of the intended purpose. However, the Engineer should evaluate such suitability, and based upon such evaluations, incorporate into contract documents any necessary changes to code requirements to address the specific requirements of the application that is outside the scope of the code. The Structural Welding Committee encourages the Engineer to consider the applicability of other AWS D1 codes for applications involving aluminum (AWS D1.2), sheet steel equal to or less than 3/16 in thick [5 mm] (AWS D1.3), reinforcing steel (AWS D1.4), and stainless steel (AWS D1.6). The AASHTO/AWS D1.5 Bridge Welding Code was specifically developed for welding highway bridge components and is recommended for those applications.

1.3 Definitions

The welding terms used in this code shall be interpreted in conformance with the definitions given in the latest edition of AWS A3.0, *Standard Welding Terms and Definitions*, supplemented by Annex K of this code and the following definitions:

1.3.1 Engineer. “Engineer” shall be defined as a duly designated individual who acts for, and in behalf of, the Owner on all matters within the scope of the code.