Abstract

This code supplements the requirements of AWS D1.1/D1.1M, Structural Welding Code—Steel. This code is intended to be applicable to welded joints in Seismic Force Resisting Systems designed in accordance with the AISC Seismic Provisions. Clauses 1–7 constitute a body of rules for the regulation of welding in Seismic Force Resisting Systems. There are seven mandatory annexes in this code. A commentary of the code is included with the document.
Statement on the Use of American Welding Society Standards

All standards (codes, specifications, recommended practices, methods, classifications, and guides) of the American Welding Society (AWS) are voluntary consensus standards that have been developed in accordance with the rules of the American National Standards Institute (ANSI). When AWS American National Standards are either incorporated in, or made part of, documents that are included in federal or state laws and regulations, or the regulations of other governmental bodies, their provisions carry the full legal authority of the statute. In such cases, any changes in those AWS standards must be approved by the governmental body having statutory jurisdiction before they can become a part of those laws and regulations. In all cases, these standards carry the full legal authority of the contract or other document that invokes the AWS standards. Where this contractual relationship exists, changes in or deviations from requirements of an AWS standard must be by agreement between the contracting parties.

AWS American National Standards are developed through a consensus standards development process that brings together volunteers representing varied viewpoints and interests to achieve consensus. While AWS administers the process and establishes rules to promote fairness in the development of consensus, it does not independently test, evaluate, or verify the accuracy of any information or the soundness of any judgments contained in its standards.

AWS disclaims liability for any injury to persons or to property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, or reliance on this standard. AWS also makes no guarantee or warranty as to the accuracy or completeness of any information published herein.

In issuing and making this standard available, AWS is neither undertaking to render professional or other services for or on behalf of any person or entity, nor is AWS undertaking to perform any duty owed by any person or entity to someone else. Anyone using these documents should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. It is assumed that the use of this standard and its provisions is entrusted to appropriately qualified and competent personnel.

This standard may be superseded by new editions. This standard may also be corrected through publication of amendments or errata, or supplemented by publication of addenda. Information on the latest editions of AWS standards including amendments, errata, and addenda is posted on the AWS web page (www.aws.org). Users should ensure that they have the latest edition, amendments, errata, and addenda.

Publication of this standard does not authorize infringement of any patent or trade name. Users of this standard accept any and all liabilities for infringement of any patent or trade name items. AWS disclaims liability for the infringement of any patent or product trade name resulting from the use of this standard. AWS does not monitor, police, or enforce compliance with this standard, nor does it have the power to do so.

Official interpretations of any of the technical requirements of this standard may only be obtained by sending a request, in writing, to the appropriate technical committee. Such requests should be addressed to the American Welding Society, Attention: Managing Director, Technical Services Division, 8669 NW 36 St, # 130, Miami, FL 33166 (see Annex I). With regard to technical inquiries made concerning AWS standards, oral opinions on AWS standards may be rendered. These opinions are offered solely as a convenience to users of this standard, and they do not constitute professional advice. Such opinions represent only the personal opinions of the particular individuals giving them. These individuals do not speak on behalf of AWS, nor do these oral opinions constitute official or unofficial opinions or interpretations of AWS. In addition, oral opinions are informal and should not be used as a substitute for an official interpretation.

This standard is subject to revision at any time by the AWS D1 Committee on Structural Welding. It must be reviewed every five years, and if not revised, it must be either reaffirmed or withdrawn. Comments (recommendations, additions, or deletions) and any pertinent data that may be of use in improving this standard are requested and should be addressed to AWS Headquarters. Such comments will receive careful consideration by the AWS D1 Committee on Structural Welding and the author of the comments will be informed of the Committee’s response to the comments. Guests are invited to attend all meetings of the AWS D1 Committee on Structural Welding to express their comments verbally. Procedures for appeal of an adverse decision concerning all such comments are provided in the Rules of Operation of the Technical Activities Committee. A copy of these Rules can be obtained from the American Welding Society, 8669 NW 36 St, # 130, Miami, FL 33166.
Foreword

This foreword is not part of this standard but is included for informational purposes only.

This is the third edition of the AWS D1.8/D1.8M, Structural Welding Code—Seismic Supplement.

Editorial and technical revisions from the previous edition are indicated by underlining text. Changes in tables and figures have a single, vertical line in the margin. The following is a list of the most significant revisions from the 2009 edition:

Clause 6 entitled “Fabrication” has been reorganized for user readability. This reorganization has required renumbering of the majority of the subclauses within Clause 6 as well as extensive reference changes throughout this supplement.

Clause 3: Doubler is now defined.

Clause 4.3: A new clause that defines when joint details for doublers are suitable for use in a prequalified WPS. The clause also states when macroetch tests are required and acceptance criteria for macroetch specimens.

Figure 4.3: A new figure that depicts the doubler to column flange joint detail was added.

5.1.1(1): The words “complete joint penetration groove weld” were added for clarification.

5.1.1(3): The words “in the groove” were added for clarification.

5.1.2: The words “in the flat position” were added for clarification.

6.2.1(2): Solid GMAW electrodes classified in AWS A5.18/A5.18M or AWS A5.28/A5.28M as ER70 or ER80 [ER48 or ER55] tensile strength have been added to the list of exempt filler metals.

6.2.1(4): AWS A5.29/5.29M E70 or E80 [E49 or E55] low alloy FCAW electrodes have been added to the list of exempt filler metals.


6.2.1(6): A new subclause was added to the list of exempt filler metals regarding E90 [E62] Low Alloy SMAW, FCAW, GMAW composite (metal cored) and solid electrodes, and low alloy electrode/flux SAW combinations that have been optionally tested by the filler metal manufacturer in accordance with AWS A5.20/A5.20M:2005 Clause 17.

6.2.2: Additional parameters were added to the Lowest Anticipated Service Temperature for 70 ksi, 80 ksi, and 90 ksi [490 MPa, 550 MPa, and 620 MPa] filler metals.

6.3.1.3: ER70 and ER80 [ER48 and ER55] GMAW solid electrodes were added to the list of exceptions.

6.8.1(2): For carbon steel FCAW electrodes classified with the supplemental designator “-D” the heat input range prescribed in Clause 17 of AWS A5.20/A5.20M:2005 was added to the list of acceptable heat input limits.

6.8.1(3): The tensile strength was clarified.

6.8.1(4): For low alloy electrodes classified as 90 ksi [620 MPa] tensile strength, SMAW, GMAW metal core and solid electrodes, FCAW electrodes, and SAW electrode/flux combinations were added to the list of acceptable heat input limits.

6.8.1(5): For AWS A5.36/A5.36M:2012 Clause 16 for carbon and low alloy steel FCAW and GMAW-metal core electrodes classified with the supplemental designator “-D” was added to the list of acceptable heat input limits along with a note offering further explanation.
6.12.3: A new clause regarding tack welds that attach steel backing in the protected zone.

6.14: The words “weld root” were replaced with back weld for clarification.

6.18.6: A new clause regarding the repair of mislocated holes.

6.18.7: A new clause regarding the repair of mislocated stud welds.

6.18.8: A new clause regarding the repair of mislocated screws and shot pins.

Table 6.1: The addition of parameters for 90 ksi [620 MPa] filler metal and a new footnote regarding the offset method.

Table 6.2: The addition of parameters for 90 ksi [620 MPa] filler metal. New footnotes regarding the offset method and additional parameters for LAST.

Table 6.3: AWS A5.36/A5.36M:2012 was added to the table.

Figure 6.1(B): New text depicting the figure was added for clarification.


Table A.2: Electrode Classification Strength E90 [E62] was added to the table.


B7: Additional text regarding CVN toughness for welds using 70 ksi, 80 ksi, and 90 ksi [490 MPa, 550 MPa, and 620 MPa].

E3.2: AWS A5.36/A5.36M:2012 Clause 15, Diffusible Hydrogen Test was added as an additional testing procedure option for diffusible hydrogen levels.

G10: Subclause modified for clarification.

**Background.** Damage sustained by welded steel moment-frame buildings in the 1994 Northridge earthquake, and extensive research conducted by the FEMA/SAC program following that earthquake, demonstrated that in order to obtain adequate performance of welded steel structures under conditions of severe earthquake-induced inelastic straining, additional controls on design, detailing, materials, workmanship, testing, and inspection are necessary. This research resulted in substantive changes to the AISC Seismic Provisions, which control the design of steel Seismic Force Resisting Systems (SFRS) designed to withstand severe inelastic straining as well as certain aspects of the materials and detailing of these systems. The provisions contained in this standard complement the AISC Seismic Provisions and are intended to ensure that welded joints that are designed to undergo significant repetitive inelastic strains as a result of earthquakes, or that are used to connect members designed to resist such inelastic strains, have adequate strength, notch toughness, and integrity to perform as intended. This code, together with AWS D1.1/D1.1M, specifies the acceptable materials, procedures, and workmanship for constructing welded joints in SFRS designed in accordance with the AISC Seismic Provisions as well as the procedures and acceptance criteria for quality control and quality assurance inspection of welded joints in the SFRS. In some regions of the U.S., with low risk of intense earthquake shaking, building codes permit design of steel Seismic Force Resisting Systems that do not conform to the requirements of the AISC Seismic Provisions. The requirements of this code apply only to the SFRS in structures designed in accordance with the AISC Seismic Provisions and need not be applied to structures not designed to those provisions.

**Commentary.** The Commentary is nonmandatory and is intended only to provide insight, information, and provision rationale.

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

**Errata.** All errata to a standard shall be published in the *Welding Journal* and posted on the AWS website (www.aws.org/standards/page/errata).

**Suggestions.** Comments and suggestions for the improvement of this standard are welcome. They should be sent to the Secretary, D1L Subcommittee on Seismic Provisions, American Welding Society, 8669 NW 36 St, # 130, Miami, FL 33166.
Table of Contents

Personnel .........................................................................................................................v
Foreword ............................................................................................................................vii
List of Tables ...................................................................................................................xi
List of Figures .................................................................................................................xi

1. General Requirements ..................................................................................................1
   1.1 Scope .........................................................................................................................1
   1.2 Standard Units of Measurement ............................................................................1
   1.3 Safety Precautions ..................................................................................................1
   1.4 Responsibilities .......................................................................................................2
   1.5 Limitations ...............................................................................................................3
   1.6 Welding Symbols .....................................................................................................3

2. Normative References ..................................................................................................5

3. Terms and Definitions ...................................................................................................7

4. Welded Connection Details ..........................................................................................9
   4.1 Corner Clips of Continuity Plates and Stiffeners .....................................................9
   4.2 Transitions in Thicknesses and Widths .................................................................9
   4.3 Joint Details for Doublers .......................................................................................9

5. Welder Qualification .....................................................................................................13
   5.1 Supplemental Welder Qualification Testing ...........................................................13
   5.2 Welder Qualification Period ..................................................................................13
   5.3 Welder Performance Qualification Record Information .......................................13

6. Fabrication .....................................................................................................................15
   Part A—Filler Metal and Weld Metal .............................................................................15
   6.1 Filler Metal and Weld Metal ...................................................................................15
   Part B—Additional Requirements for Demand Critical Filler Metal and Weld Metal ...15
   6.2 Heat Input Envelope ..............................................................................................15
   6.3 Production Lot Control ..........................................................................................16
   6.4 FCAW Electrode Packaging, Storage, and Exposure .............................................17
   Part C—Welding Procedure Specifications ................................................................18
   6.5 Welding Processes .................................................................................................18
   6.6 Welding Procedure Specifications (WPSs) .............................................................18
   6.7 Maximum Interpass Temperature .........................................................................18
   6.8 Heat Input ...............................................................................................................19
   6.9 Bottom Flange Welding Sequence .......................................................................19
   6.10 Welder Identification ..........................................................................................19
   Part D—Details ...............................................................................................................20
   6.11 Weld Access Holes ...............................................................................................20
   6.12 Tack Welding Requirements ...............................................................................20
   6.13 Removal of Backing and Weld Root Treatment ..................................................21
   6.14 Reinforcing Fillet Welds at Removed Weld Backing Locations ..........................21
   6.15 Fillet Welds at Left-In-Place Steel Backing ..........................................................21

ix
List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 Filler Metal Mechanical Property Requirements</td>
<td>23</td>
</tr>
<tr>
<td>6.2 Mechanical Property Requirements for Demand Critical Welds</td>
<td>23</td>
</tr>
<tr>
<td>6.3 Diffusible Hydrogen Testing Requirements</td>
<td>24</td>
</tr>
<tr>
<td>A.1 Heat Input Envelope Testing—Heat Input, Preheat, and Interpass Temperatures</td>
<td>35</td>
</tr>
<tr>
<td>A.2 All Weld Metal Mechanical Properties; Yield Strength, Tensile Strength, Elongation, and CVN Toughness Requirements</td>
<td>35</td>
</tr>
<tr>
<td>B.1 Filler Metal Essential Variables—FCAW-S Substrate/Root</td>
<td>39</td>
</tr>
<tr>
<td>B.2 Filler Metal Essential Variables—FCAW-S Fill</td>
<td>39</td>
</tr>
</tbody>
</table>

Commentary

C-1.1 Removal of Tabs and Backing .............................................................. 73

List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1 Transition of Butt Joints in Parts of Unequal Thickness</td>
<td>10</td>
</tr>
<tr>
<td>4.2 Transition of Butt Joints in Parts of Unequal Widths</td>
<td>11</td>
</tr>
<tr>
<td>4.3 Doubler to Column Flange Joint Detail</td>
<td>11</td>
</tr>
<tr>
<td>6.1 Reinforcing Fillet Weld Requirements</td>
<td>25</td>
</tr>
<tr>
<td>6.2 Alternate Geometry—Beam Flange Weld Access Hole Detail</td>
<td>26</td>
</tr>
<tr>
<td>6.3 Acceptable Tab Removal Conditions</td>
<td>27</td>
</tr>
<tr>
<td>6.4 Acceptable and Unacceptable Use of End Dams</td>
<td>28</td>
</tr>
<tr>
<td>A.1 Heat Input Envelope Test Plate</td>
<td>36</td>
</tr>
<tr>
<td>B.1 Intermix Test Plate</td>
<td>40</td>
</tr>
<tr>
<td>B.2 Interface Scribe Line Location</td>
<td>41</td>
</tr>
<tr>
<td>B.3 Intermix CVN Test Specimen Location</td>
<td>41</td>
</tr>
<tr>
<td>D.1 Test Plate Configuration for Option A</td>
<td>48</td>
</tr>
<tr>
<td>D.2 Test Plate Configuration for Option B</td>
<td>49</td>
</tr>
<tr>
<td>D.3 Test Plate Configuration Illustration</td>
<td>49</td>
</tr>
<tr>
<td>D.4 Location of Side Bend Specimens on Test Plates—Supplemental Welder Qualification</td>
<td>50</td>
</tr>
</tbody>
</table>

Commentary

C-1.1 Example RBS/Column Strong Axis Connection .................................. 74
C-1.2 Example Eccentric Brace/Link/Column Connection                    | 75       |
C-1.3 Example WUF-W/Column Strong Axis Connection                       | 76       |
C-4.1 Curved Corner Clip                                               | 80       |
C-4.2 Straight Corner Clip                                             | 80       |
C-6.1 Measurement of Preheat and Interpass Temperature                 | 93       |
C-6.2 Beam Flange to Column—Fillet Welds at Left-in-Place Steel Backing | 93       |
C-6.3 Continuity Plate Copes without Weld Tabs                         | 94       |
1. General Requirements

1.1 Scope

The provisions of this code supplement the provisions of AWS D1.1/D1.1M, Structural Welding Code—Steel, and shall apply to the design, fabrication, quality control, and quality assurance of welded joints designed in accordance with the AISC Seismic Provisions for Structural Steel Buildings. All provisions of AWS D1.1/D1.1M for statically loaded structures shall apply to the designated welds, except as specifically modified herein.

1.2 Standard Units of Measurement

This standard makes use of both U.S. Customary Units and the International System of Units (SI). The latter are shown within brackets ([ ]) or in appropriate columns in tables and figures. The measurements may not be exact equivalents; therefore, each system must be used independently.

1.3 Safety Precautions

Safety and health issues and concerns are beyond the scope of this standard and therefore are not fully addressed herein. Safety and health information is available from the following sources:

American Welding Society:

(1) ANSI Z49.1, Safety in Welding, Cutting, and Allied Processes

(2) AWS Safety and Health Fact Sheets

(3) Other safety and health information on the AWS website

Material or Equipment Manufacturers:

(1) Safety Data Sheets supplied by materials manufacturers

(2) Operating Manuals supplied by equipment manufacturers

Applicable Regulatory Agencies

Work performed in accordance with this standard may involve the use of materials that have been deemed hazardous, and may involve operations or equipment that may cause injury or death. This standard does not purport to address all safety and health risks that may be encountered. The user of this standard should establish an appropriate safety program to address such risks as well as to meet applicable regulatory requirements. ANSI Z49.1 should be considered when developing the safety program.