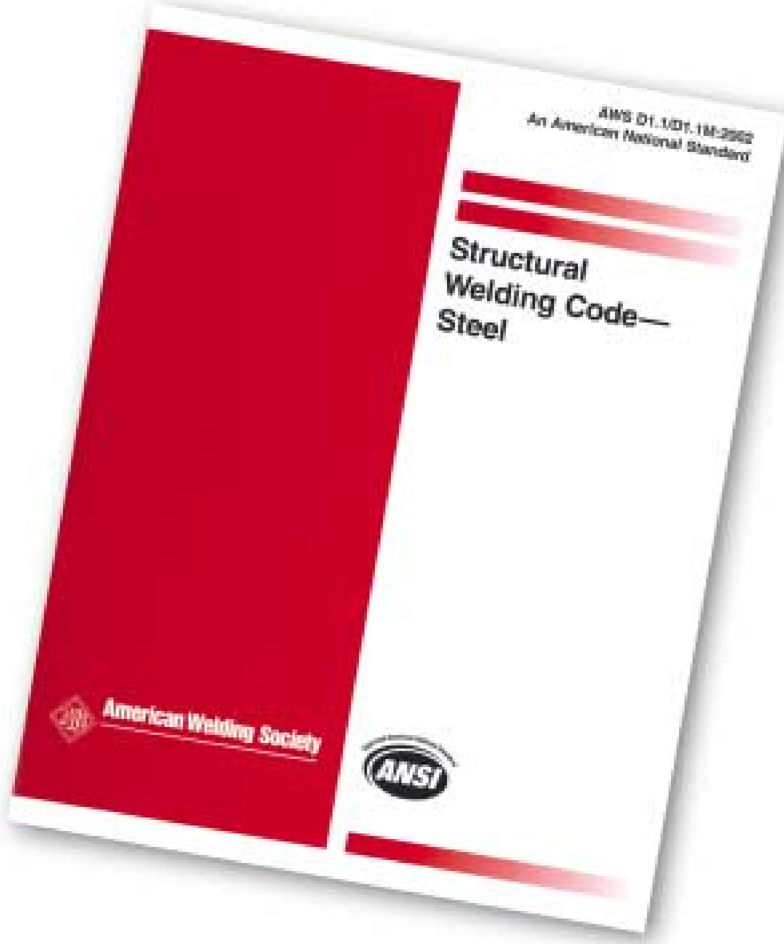
Inside LOOK

Hardy Campbell, P.E.



The American Welding Society *D1.1 Code* was revised and updated for 2002 to reflect current practices in structural steel fabrication.

The American Welding Society *D1.1 Code* is renowned throughout the world for its utility, flexibility and assurance of welding quality. In a continuing effort to improve on these attributes, the AWS D1 Structural Welding Committee has approved a number of revisions to the ANSI / AWS *D1.1:2000 Code* for the 2002 edition.

IDENTIFICATION CHANGED

The first thing you'll notice is the way the *Code* is identified: AWS D1.1 / D1.M:2002. The "ANSI" has been dropped because the ANSI logo is now on the book's cover, which serves as adequate identification of ANSI-approval status.

D1.1 / D1.M indicates the document uses U.S. customary units (D1.1) and SI metric numbers (D1.1M). One set of numbers is in brackets (SI) and the other is not (U.S.). The document consists of two codes sharing a common text but distinguished by the use of separate dimensional standards. Users must not mix and match the two. For example, a contractor cannot suddenly decide, when U.S. dimensions fail to conform to the *Code*, to use the SI version instead. The two sets of dimensions must be kept completely separate. There is no "dominant" units system; each must be treated independently of the other.

EXPANDED RESPONSIBILITIES

A new section on responsibilities (1.4) has been added that describes the responsibilities of the engineer, contractor, contractor's inspector and verification inspector. Added commentary elaborates on the *Code* text. A new type of contractor, the original equipment manufacturer, is defined to describe situations when a single contractor assumes the responsibilities of the engineer.

The *Code* recognizes that the engineer has sole authority to modify any *Code* provision. This authority is intended to provide flexibility when applying the generic D1.1 document to industrial applications. *Code* provisions might be conservative for some applications, but not for others. There might also be situations the *Code* does not address, which the engineer needs to include in the contract specifications.

For example, Charpy V-notch (CVN) testing of welding procedures is not a *Code* requirement. If the engineer wants the contractor to perform the welding procedure, it must be explicitly stated in the contract documents, including such information as test temperatures and impact energies.

Another example is the need to nondestructively test plate or beam connections with a non-visual method (e.g., UT or RT). Nondestructive examination (NDE) is not a *Code* requirement, but if the engineer orders it, it must be explicitly stated contractually and include additional information, such as which joints and connections are to be scanned and the extent of scanning (e.g., partial or 100%).

The addition of this new section should alert engineers to the impor-

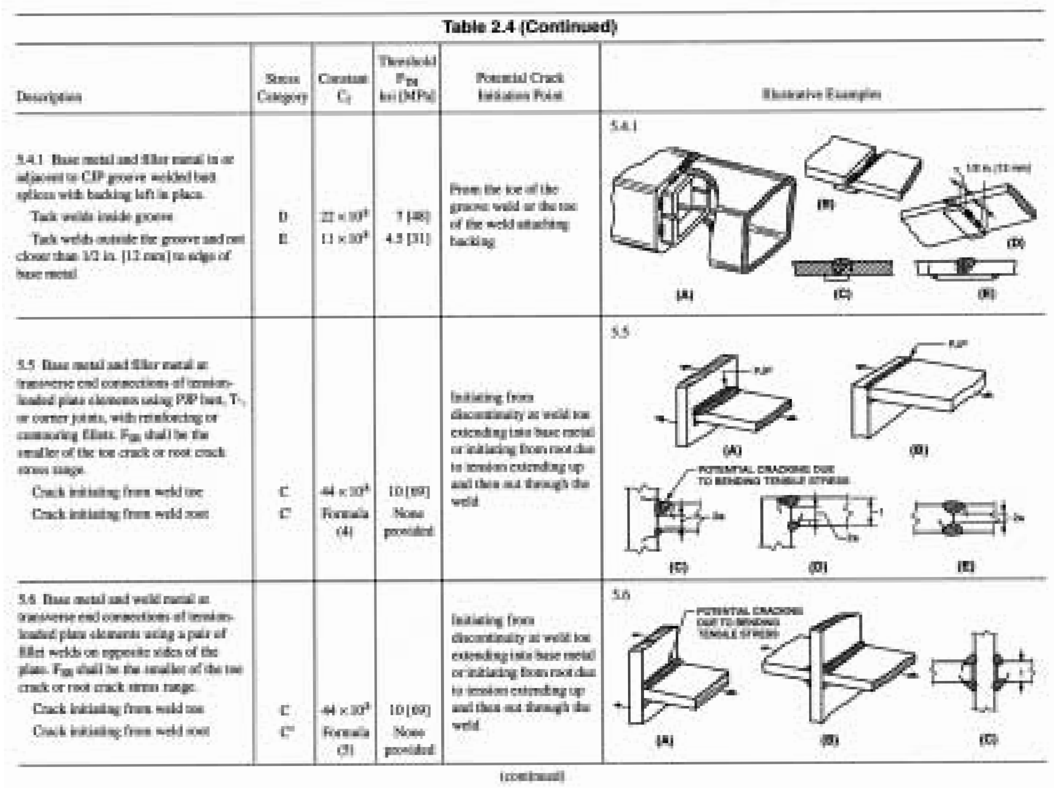


Table 2.4 (Continued)

Description	Stress Category	Constant C_f	Threshold F_{TH} ksi [MPa]	Potential Crack Initiation Point	Illustrative Examples
5.4.1 Base metal and filler metal in or adjacent to CJP groove welded butt splices with backing left in place. Tack welds inside groove Tack welds outside the groove and not closer than 1/2 in. [12 mm] to edge of base metal	 D E	 22×10^8 11×10^8	 7 [48] 4.5 [31]	From the toe of the groove weld or the toe of the weld attaching backing	5.4.1 (A) (B) (C) (D) (E)
5.5 Base metal and filler metal at transverse end connections of tension-loaded plate elements using PJP butt, T-, or corner joints, with reinforcing or contouring fillets. F_{SR} shall be the smaller of the toe crack or root crack stress range. Crack initiating from weld toe Crack initiating from weld root	 C C′	 44×10^8 Formula (4)	 10 [69] None provided	Initiating from discontinuity at weld toe extending into base metal or initiating from root due to tension extending up and then out through the weld	5.5 (A) (B) (C) (D) (E) POTENTIAL CRACKING DUE TO BENDING TENSILE STRESS
5.6 Base metal and weld metal at transverse end connections of tension-loaded plate elements using a pair of fillet welds on opposite sides of the plate. F_{SR} shall be the smaller of the toe crack or root crack stress range. Crack initiating from weld toe Crack initiating from weld root	 C C″	 44×10^8 Formula (5)	 10 [69] None provided	Initiating from discontinuity at weld toe extending into base metal or initiating from root due to tension extending up and then out through the weld	5.6 (A) (B) (C) POTENTIAL CRACKING DUE TO BENDING TENSILE STRESS

(continued)

A partial view of the new table 2.4. This table presents a variety of stress conditions with accompanying illustrations of connections, joint types, and welds in a greatly expanded and more visual format.

tance of writing contract documents that are clear and concise vis-à-vis *Code* modifications. Additionally, the responsibilities of the contractor and inspectors are summarized to provide a clear understanding of what is expected of them.

CHANGES IN WELDED CONNECTIONS

Parts A, B, and C of Section 2 on "Design of Welded Connections" has been extensively reorganized and modified. Some of the major changes include the following:

1 A provision was added to clarify the *Code* intent that, when notch tough welds are required, the engineer must specify this requirement in the contract documents.

2 Imposition of new limits on maximum effective length of fillet welds loaded at their ends.

3 T-joints are defined as having joined parts that form angles between 80º and 100º.

4 Maximum fillet weld sizes are clearly described as pertaining only to lap joints. The industry myth that the *Code* prohibits the use of fillet welds larger than the base-metal thickness is true only for certain lap joints, and never for T-joints. The editorial addition of lap joints to the provision should end this persistent confusion.

5 A provision is added on base metal through-thickness loading.

6 A new Table 2.4 describing fatigue limits for weld and joint types has replaced the 2000 version and Fig. 2.8. This greatly expanded table, which now includes illustrations (see table), covers a much broader range of connections and weld types. The allowable stress ranges described in a new Fig. 2.11 are calculated using formulae now described in the new provision 2.15.2.

7 New provisions describing the status of backing were added. Though other provisions in the *Code,* notably in the Fabrication section, describe situations where backing was to be removed, this new provision (2.16.2) gives the engineer design instructions about what information must be provided in contract drawings or documents.

HEAT TREATMENT STATUS

Post-weld heat treatment is accorded pre-qualified status in the new provision 3.14. Certain limitations required to achieve this include yield stress caps, steel manufacturing process, and the absence of contractually specified toughness requirements.

FILLER METALS CLARIFIED

Changes made to Table 3.1 (Prequalified Matching Filler Metal Requirements) are detailed below.

1 ASTM A36 and A709 Grade 36 have been divided by thickness limits into Groups I and II. The rationale for this change was to recognize the higher strength levels commonly found in current ASTM A36 steel while still permitting the field attachment of "thinner" parts, as is commonly done with SMAW on sites where keeping filler

metal hot may no always be easy. The committee felt that thicker materials would be susceptible to cracking, as has always been assumed for materials near or above 50 ksi. ASTM A36 was still subject to a maximum tensile strength of 80ksi and thinner parts would be less likely to exhibit problems.

2 ASTM A529 (42-ksi yield) has been deleted and Grades 50 and 55 added to Group II.

3 ASTM A572 Grade 55 has been added to Group II.

4 FCAW electrodes with the -11 suffix are limited to welding thicknesses equal to or less than 1/2 in. Some electrode manufacturers that produce this self-shielded electrode (suitable for single/multiple pass welds made in any position) limit the thickness. Welding on thicker base metal could produce a buildup of alloying elements in the deposited weld metal, which could increase fracture sensitivity. This exclusion from pre-qualified status does not prohibit such thicknesses from being qualified by welding procedure specification (WPS) testing.

ADDRESSING TOUGHNESS TESTING

In order to more comprehensively address the issue of Charpy V-notch (CVN) testing for toughness, the following changes have been made:

1 A new Table 4.6 has been added to provide essential variable limits for WPSs that require CVN tests. These variable limits will supplement Table 4.5's limits only when CVN testing is contractually specified. Table 4.6 focuses on concerns that would not necessarily affect a non-CVN-testing application, such as the change from stringer passes to weave passes when welding vertically. A weave pass represents a higher heat input, with resulting grain coarsening and degraded toughness. Changing a WPS that specifies a lower heat-input stringer pass to a weave pass justifies requiring the new weave WPS be qualified separately. Users will need to include these Table 4.6 variables on their CVN-tested WPS.

2 The WPS plate and pipe test assemblies now identify CVN specimen locations when such testing is contractually specified.

3 Annex III (CVN test specimens) has been extensively revised, including the addition of criteria for subsize specimens.

MORE COMMENTARY

Commentary has been added to facilitate the ultrasonic testing of welded joints with backing left in place. In the past, such joints have caused difficulties in interpreting ultrasonic testing (UT) signals that result from reflection off the backing. This Commentary will hopefully enable UT operators to write scanning procedures that recognize these "built-in" reflectors.

An addition to Tables 6.2 and 6.3 (UT acceptance criteria) relaxes the scanning sensitivity of doubled-sided CJP groove joints in tension. The requirement of adding 4 dB to the scanning levels of the root of these welds presented a concern, particularly in the bridge industry, that root flaws resulting from inadequate backgouging might go undetected without heightened sensitivity. The committee has decided to waive this requirement when the contractor demonstrates that, by means of magnetic-particle testing, the backgouged root is free of discontinuities prior to completion of welding. Thus the root would be subject to normal scanning levels.

Changes were also made to Annex IX (Manufacturers' Stud Base Qualification Requirements) that address the welding of studs through decking.

THE LATEST EDITION

The 2002 edition of *D1.1 Structural Welding Code—Steel* is now available at the same price as in 2001. American Welding Society members can purchase the *Code* for $258, non-members, $344. Place orders with Global Engineering Documents at 800.854.7179. Orders can also be made on-line through the AWS web site at www.aws.org.

Hardy Campbell, P.E., is a former senior staff engineer at AWS and secretary to the AWS D1 Structural Welding Committee. He currently works as a project engineer for Bay Ltd., based in Corpus Christi, TX. This article also appeared in the December 2001 issue of Welding Journal.