

AWS D1.4/D1.4M:2018
An American National Standard

Structural Welding Code— Steel Reinforcing Bars



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AWS D1.4/D1.4M:2018
An American National Standard

Approved by the
American National Standards Institute
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Structural Welding Code—Steel Reinforcing Bars

8th Edition

Supersedes AWS D1.4/D1.4M:2011

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 requirements for welding steel reinforcing bars in most reinforced concrete applications. It contains a body of rules for the regulations of welding steel reinforcing bars and provides suitable acceptance criteria for such welds.



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Foreword

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

In 1961, the American Welding Society published its first reinforcing steel welding standard, AWS D12.1-61, *Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction*. The D12 Committee was disbanded some time after publication of the 1961 code and before publication of the 1975 edition.

The 1961 document was replaced with a greatly revised version, AWS D12.1-75, *Reinforcing Steel Welding Code*, with the format patterned after the AWS D1.1-72, *Structural Welding Code*. The 1975 code was produced by the AWS Structural Welding Committee but was not renumbered to reflect this committee change. As with ANSI/AWS D1.1, AWS D12.1-75 was designed as a self-contained code, including within it the qualification of welders and procedures, and requirements for workmanship, quality, and inspection.

The listings of materials and welding processes were revised in the D12.1-75 code. Items newly introduced were the carbon equivalent method for determining preheat, the parenthetical inclusion of metric (SI) conversions, and the two different methods of joint strength determination.

The AWS D12.1-75 document was revised and the title changed to ANSI/AWS D1.4-79, *Structural Welding Code—Reinforcing Steel*. Since the 1979 edition of ANSI/AWS D1.4, *Structural Welding Code—Reinforcing Steel*, was issued, further use by designers, engineers, and fabricators has necessitated a number of changes to the requirements; the 1992, 1998, 2005, and 2011 editions reflected these changes.

The evolution of AWS D1.4/D1.4M, *Structural Welding Code—Steel Reinforcing Bars*, is shown below:

AWS D12.1-61	<i>Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction;</i>
AWS D12.1-75	<i>Reinforcing Steel Welding Code;</i>
ANSI/AWS D1.4-79	<i>Structural Welding Code—Reinforcing Steel;</i>
ANSI/AWS D1.4-92	<i>Structural Welding Code—Reinforcing Steel;</i>
ANSI/AWS D1.4-98	<i>Structural Welding Code—Reinforcing Steel;</i>
AWS D1.4/D1.4M:2005	<i>Structural Welding Code—Reinforcing Steel;</i>
AWS D1.4/D1.4M:2011	<i>Structural Welding Code—Reinforcing Steel; and</i>
AWS D1.4/D1.4M:2018	<i>Structural Welding Code—Steel Reinforcing Bars.</i>

Changes in Code Requirements. Underlined text in the subclauses, tables, or figures indicates an editorial or technical change from the 2011 edition. A vertical line in the margin indicates a revision from the 2011 edition.

Summary of Changes

Clause/Table/ Figure/Annex	Modification
Clause 1	Restructured to identify new safety and health information; new materials added. GTAW is now permitted as a prequalified welding process.
Clause 2	New clause that lists all normative references. This replaces subclause 1.9 from the 2011 edition.
Clause 3	New clause that provides terms and definitions specific to this standard. It replaces subclause 1.5 from the 2011 edition.
Clause 4	Previously Clause 2 in the 2011 edition. Base metal stresses and allowable stresses in welds were removed and replaced with new content on the design of welded joints. New Table 4.1 covers design strength and the allowable strength of welded joints.
Clause 5	Previously Clause 3 in the 2011 edition. New content on lap joints: bar diameter range, effects of eccentricity, and lap joints in an anchorage. Figures 5.1 through 5.5 modified for clarification.
Clause 6	Previously Clause 4 in the 2011 edition. New content on foreign materials and coatings, weld size. Figures 6.1 revised for clarity. Figure 6.2 extensively revised to include new schedules for weld profiles.
Clause 7	Previously Clause 5 in the 2011 edition. New content on GTAW electrodes and filler metals. Tables 7.1 revised to include several A5 filler metal specifications, most notably AWS A5.36.
Clause 8	Previously Clause 6 in the 2011 edition. Table 8.2 revised to include GTAW, bar diameter groups, and AWS A5.36. Figure 8.5 revised for clarity. Figure 8.8 is new.
Clause 9	Previously Clause 7 in the 2011 edition. Radiographic methodology shall now conform to ASTM E94 .
Annex A	Sample forms now include GTAW.
Commentary	Commentary is new for this edition. This is a practice used by other D1 codes and as such will now be included as part of this standard.

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.

Errata. It is the Structural Welding Committee's Policy that all errata should be made available to users of this 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 D1.4/D1.4M:2018](#), *Structural Welding Code—Steel Reinforcing Bars* are welcome. Submit comments to the Managing Director, Standards Development, American Welding Society, 8669 NW 36 St, # 130, Miami, FL 33166; telephone (305) 443-9353; fax (305) 443-5951; e-mail info@aws.org; or via the AWS web site <<http://www.aws.org>>.

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Structural Welding Code—Steel Reinforcing Bars

1. General Requirements

1.1 Scope

This code shall apply to the welding of the following:

- (1) Steel reinforcing bar to steel reinforcing bar, and
- (2) Steel reinforcing bar to carbon or low-alloy structural steel.

When this code is stipulated in contract documents, conformance with all provisions shall be required, except for those provisions that the Engineer or contract documents specifically modifies or exempts.

1.2 Units of Measurement

This standard makes use of both the 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

Safety and health issues and concerns are beyond the scope of this standard; some safety and health information provided, but such issues 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 the 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.

1.4 Application

1.4.1 General Requirements. This code shall be used in conjunction with the prescribed general building code requirements and is applicable to all welding of steel reinforcing bars, using the processes listed in 1.6, and performed as a part of reinforced concrete construction or in the manufacture of precast concrete components.

1.4.2 Impact Properties. The weldments specified in this code shall not be used where impact properties are a requirement of the general specification. Impact testing requirements of welded steel reinforcing bars are not included in this code.

1.4.3 Engineering Approval. All references to the need for approval shall be interpreted to mean approval by the Engineer.

1.5 Steel Reinforcing Bar Base Metal

1.5.1 Materials. Steel reinforcing bar base metal in this code shall conform to the requirements of the latest edition of one of the ASTM specifications listed within this paragraph. Combinations of any of these steel reinforcing bar base metals, when welded, shall use a welding procedure specification (WPS) qualified in conformance with Clause 8:

- (1) ASTM A615/A615M
- (2) ASTM A706/A706M
- (3) ASTM A767/A767M: zinc-coated (galvanized) steel reinforcing bars that meet the requirements of ASTM A615/A615M or ASTM A706/A706M
- (4) ASTM A775/A775M: epoxy-coated steel reinforcing bars that meet the requirements of ASTM A615/A615M or ASTM A706/A706M
- (5) ASTM A934/A934M: epoxy-coated prefabricated steel reinforcing bars that meet the requirements of ASTM A615/A615M or ASTM A706/A706M
- (6) ASTM A1055/A1055M: zinc and epoxy dual-coated steel reinforcing bars that meet the requirements of ASTM A615/A615M or ASTM A706/A706M
- (7) ASTM A1094/A1094M: galvanized steel reinforcing bars that meet the requirements of ASTM A615/A615M or ASTM A706/A706M

1.5.2 Unknown Composition. When a steel reinforcing bar not listed in 1.5.1 is approved under the provisions of the general building code or by the Engineer, its chemical composition and carbon equivalent shall be provided and welding procedure shall be qualified in accordance with the requirements of 8.2 and all other requirements prescribed by the Engineer.

1.5.3 Approved Base Metals. Base metals, other than those listed in 1.5.1, shall be one of the structural steels listed in the latest edition of AWS D1.1, Structural Welding Code—Steel, or any steel stipulated in the contract documents and the welding procedure shall be qualified in accordance with the requirements of 8.2 and all other requirements prescribed by the Engineer.

1.5.4 Carbon Equivalency. In order to determine minimum preheat requirements as defined in Table 7.2, the carbon equivalent of steel reinforcing bars shall be calculated as shown in 1.5.4.1 or 1.5.4.2, as applicable.

1.5.4.1 ASTM A706/A706M Carbon Equivalency Exception. For all steel reinforcing bars, except those designated as ASTM A706/A706M, the carbon equivalent shall be calculated using the chemical composition, as shown in the material test report, by the following formula:

$$C.E = \%C + \%Mn/6 \quad (Eq. 1)$$

1.5.4.2 ASTM A706/A706M Carbon Equivalency. For steel reinforcing bars designated ASTM A706/A706M, the carbon equivalent shall be calculated using the chemical composition, as shown in the material test report, by the following formula:

$$C.E. = \%C + \%Mn/6 + \%Cu/40 + \%Ni/20 + \%Cr/10 - \%Mo/50 - \%V/10 \quad (Eq. 2)$$

1.5.4.3 Unavailable Material Test Reports. If material test reports are not available, chemical analysis to determine C.E. value may be made on bars representative of the bars to be welded.

1.5.4.4 Preheat for Unknown Material Composition. If the chemical composition is not known or obtained:

- (1) For bar size number 6 [19] or less, use a minimum preheat of 300°F [150°C].
- (2) For bar size number 7 [22] or larger, use a minimum preheat of 500°F [260°C].
- (3) For all [ASTM A706/A706M](#) bar size numbers, use Table [7.2](#) C.E. values of “over 0.45% to 0.55% inclusive.”

1.6 Welding Processes

1.6.1 Welding Processes. Welding shall be performed with shielded metal arc welding (SMAW), gas metal arc welding (GMAW), gas tungsten arc welding (GTAW), or flux cored arc welding (FCAW).

1.6.2 Other Welding Processes. Other welding processes may be used when approved by the Engineer, provided that any special qualification test requirements not addressed by this code are met to ensure that welds satisfactory for the intended application will be obtained.

2. Normative References

The documents listed below are referenced within this publication and are mandatory to the extent specified herein. For undated references, the latest edition of the referenced standard in use at the date of the contract bid submission shall apply. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply.

American Welding Society (AWS) standards:

[AWS A2.4:2007](#), *Standard Symbols for Welding, Brazing, and Nondestructive Examination*;

[AWS A3.0M/A3.0](#), *Standard Welding Terms and Definitions, Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying*;

[AWS A5.1/A5.1M](#), *Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding*;

[AWS A5.5/A5.5M](#), *Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding*;

[AWS A5.12M/A5.12](#) (ISO 6848:2004 MOD), *Specification for Tungsten and Oxide Dispersed Tungsten Electrodes for Arc Welding and Cutting*;

[AWS A5.18/A5.18M](#), *Specification for Carbon Steel Electrodes and Rods for Gas Shielded Arc Welding*;

[AWS A5.20/A5.20M](#), *Specification for Carbon Steel Electrodes for Flux Cored Arc Welding*;

[AWS A5.28/A5.28M](#), *Specification for Low-Alloy Steel Electrodes and Rods for Gas Shielded Arc Welding*;

[AWS A5.29/A5.29M](#), *Specification for Low-Alloy Steel Electrodes for Flux Cored Arc Welding*;

[AWS A5.32M/A5.32](#) (ISO 14175:2008 MOD), *Welding Consumables—Gases and Gas Mixtures for Fusion Welding and Allied Processes*;

[AWS A5.36/A5.36M](#), *Specification for Carbon and Low-Alloy Steel Flux Cored Electrodes for Flux Cored Arc Welding and Metal Cored Electrodes for Gas Metal Arc Welding*;

[AWS C4.1](#), *Criteria for Describing Oxygen-Cut Surfaces*;

[AWS D1.1/D1.1M](#), *Structural Welding Code—Steel*; and

[AWS QC1](#), *Standard for AWS Certification of Welding Inspectors*.

American National Standards Institute (ANSI) standard:

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

American Society of Civil Engineers (ASCE) standard:

[ASCE/SEI 7](#), *Minimum Design Loads for Buildings and Other Structures*

American Society of Mechanical Engineers (ASME) standard:

[ASME Boiler and Pressure Vessel Code, Section V, Article 2](#)

American Society for Nondestructive Testing (ASNT) standard:

ASNT Recommended Practice No. SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*

ASTM International standards:

[ASTM A615/A615M](#), *Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement*;
[ASTM A706/A706M](#), *Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement*;
[ASTM A767/A767M](#), *Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement*;
[ASTM A775/A775M](#), *Standard Specification for Epoxy-Coated Steel Reinforcing Bars*;
[ASTM A934/A934M](#), *Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars*;
[ASTM A1055/A1055M](#), *Standard Specification for Zinc and Epoxy Dual Coated Steel Reinforcing Bars*;
[ASTM A1094/A1094M](#), *Standard Specification for Continuous Hot-Dip Galvanized Steel Bars for Concrete Reinforcement*;
[ASTM E94](#), *Standard Guide for Radiographic Examination*;
[ASTM E165](#), *Standard Practice for Liquid Penetrant Examination for General Industry*;
[ASTM E709](#), *Standard Guide for Magnetic Particle Testing*; and
[ASTM E1032](#), *Standard Test Method for Radiographic Examination of Weldments*.

Canadian Standards Association standard:

CSA Standard W178.2, *Certification of Welding Inspectors*.

3. Terms and Definitions

[AWS A3.0M/A3.0](#), *Standard Welding Terms and Definitions, Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying*, provides the basis for terminology used herein. However, the following terms and definitions are included below to accommodate usage specific to this document.

Contractor. “Contractor” shall be defined as any company, or that individual representing a company, responsible for the fabrication, erection, manufacturing, or welding, in conformance with the provisions of this code.

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

Inspector(s) (unmodified). When the term “Inspector” is used without further qualification as the specific Inspector category, it applies equally to the Contractor’s Inspector and the Quality Assurance Inspector within the limits of responsibility described in this code.

Owner. “Owner” shall be defined as the individual or company that exercises legal ownership of the product or structural assembly produced under this code.

Quality Assurance Inspector. The “Quality Assurance (QA) Inspector” is the duly designated person who acts for and on behalf of the Engineer and Owner on all matters within the scope of the contract documents and the limit of authority delegated by the Engineer.

Quality Control Inspector. The “Quality Control (QC) Inspector” is the duly designated person who acts for and on behalf of the contractor on inspection, testing, and quality matters within the scope of the contract documents.

4. Design of Welded Joints

4.1 Design Basis

4.1.1 Loads and Load Combinations. The loads and load combinations shall be as stipulated by the applicable building code. In the absence of a building code, the loads and load combinations shall be those stipulated in ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures*.

4.1.2 Strength Design. The design of welded joints shall be based on

$$\Phi R_n \geq R_u$$

where

R_u = required strength using factored load combinations

R_n = nominal strength of the joint

Φ = strength reduction factor

ΦR_n = design strength of the joint

4.1.3 Allowable Strength Design (ASD). The design of welded joints shall be based on

$$R_n / \Omega \geq R_a$$

where

R_a = required strength using nominal load combinations

R_n = nominal strength of the joint

Ω = safety factor

R_n / Ω = allowable strength of the joint

4.1.4 Strength. The design strength, ΦR_n , and the allowable strength, R_n / Ω , of welded joints shall be the weld metal strength determined according to the limit states of rupture as follows:

$$R_n = F_{nw} A_{we}$$

where

F_{nw} = nominal strength of weld metal, ksi [MPa]

A_{we} = effective area of the weld, in² [mm²]

The values of Φ , Ω , and F_{nw} and limitations thereon are given in Table 4.1.

4.2 Effective Weld Areas, Lengths, Throats, and Sizes

4.2.1 Complete Joint Penetration (CJP) Groove Welds in Direct Butt Joints. The effective weld area, A_{we} , shall be the nominal cross-sectional area of the bar being welded (see Figure 5.2). If different reinforcing bar size numbers are being welded, the weld area shall be based on the smaller reinforcing bar.

4.2.2 Flare-Bevel and Flare-V-Groove Welds. The effective weld area, A_{we} , shall be the effective weld length multiplied by the effective throat (see Figure 4.1).

4.2.2.1 Effective Weld Length. The effective weld length shall be the weld length of the specified weld size.

4.2.2.2 Minimum Effective Weld Length. The minimum effective weld length shall not be less than two times the bar diameter for equal size bars or two times the smaller bar diameter for two unequal size bars.

4.2.2.3 Effective Weld Throat. The effective throat, when filled flush to the solid section of the steel reinforcing bar, shall be 0.4 of the bar radius for flare-bevel-groove welds and 0.6 of the bar radius for flare-V-groove welds. Larger effective throats may be used to determine the design strength, provided the WPS qualifies the larger effective throat. When bars of unequal diameter are being joined, the effective throat shall be based on the radius of the smaller bar. See 8.2.6.2 for macroetch test requirements for determining effective throat.

4.2.3 Fillet Welds. The effective weld area, A_{we} , shall be the effective weld length multiplied by the effective throat. Stresses in fillet welds shall be considered as shear applied to the effective weld area for any direction of applied load.

4.2.3.1 Effective Weld Length. The effective weld length of a curved fillet weld shall be measured along the weld axis.

4.2.3.2 Effective Throat. The effective throat shall be calculated as the minimum distance from the joint root to the face of the fillet weld, minus convexity.

4.3 Other Limit States

Other limit states of failure of the base material, including tensile, shear, and block shear are beyond the scope of this code.

Table 4.1
Design Strength and Allowable Strength of Welded Joints (see 4.1.4)

Load Type and Direction Relative to Weld Axis	Weld	Strength-Reduction Factor, ϕ and Safety Factor, Ω	Nominal Strength, F_{nw}	Effective Area, A_{we}	Required Filler Metal Strength Level ^a
Complete Joint Penetration Groove Welds ^b					
Tension normal to weld axis	Strength of the joint is controlled by the base metal				Matching filler metal shall be used
Compression normal to weld axis	Strength of the joint is controlled by the base metal				Filler metal with a strength level equal to or one classification (10 ksi [70 MPa]) less than matching filler metal is permitted
Shear	Strength of the joint is controlled by the base metal				Matching filler metal shall be used
Partial Joint Penetration Groove Welds ^{c,d}					
Flare-Bevel and Flare-V-Groove Welds					
Tension or Compression Parallel to weld axis	Tension or compression in parts joined parallel to a weld need not be considered in design of welds joining the parts				Filler Metal with a strength level equal to or less than matching filler metal is permitted
Shear	Weld	$\phi = 0.75$ $\Omega = 2.00$	$0.60F_{EXX}$	See 4.2.2	
Fillet Welds—External and Internal ^{d,e}					
Shear	Weld	$\phi = 0.75$ $\Omega = 2.00$	$0.60F_{EXX}$	See 4.2.3	Filler metal with a strength level equal to or less than matching filler metal is permitted

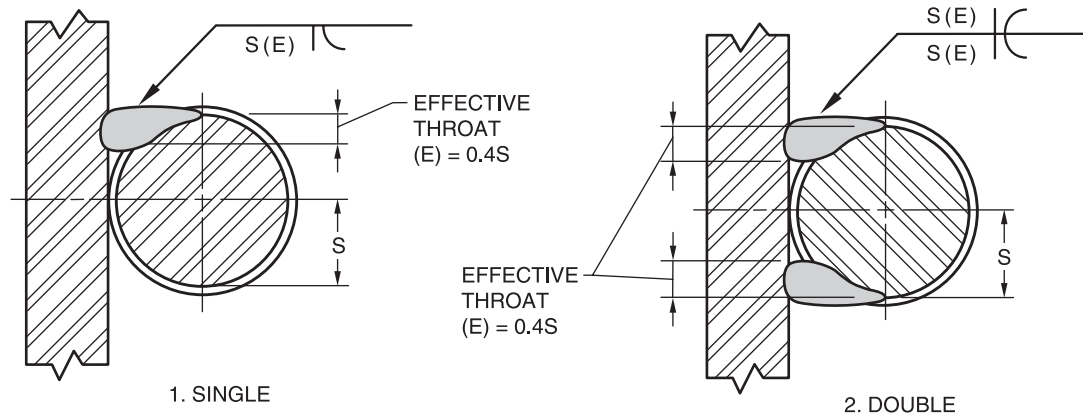
^a For matching filler metal, see Table 7.1.

^b See Figures 5.1, 5.2, and 5.5(D).

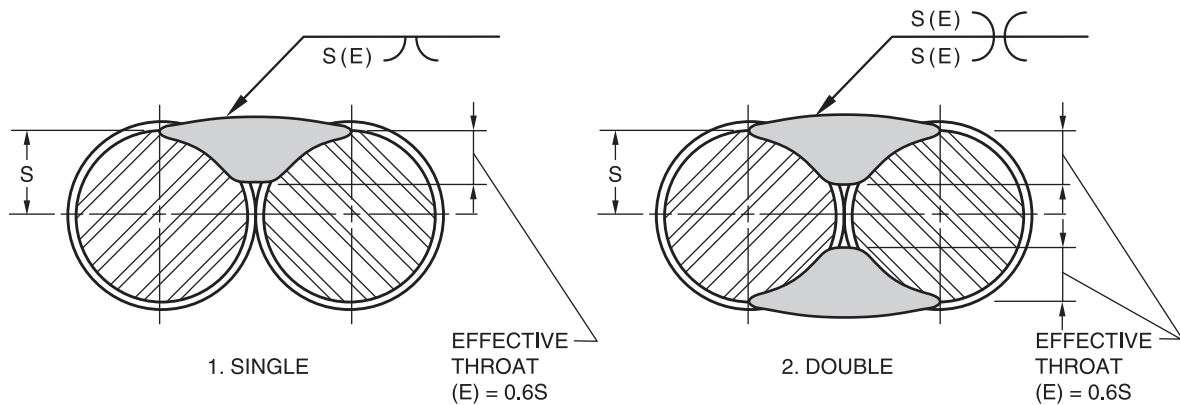
^c See Figures 5.3, 5.4, and 5.5(E).

^d Splices of steel reinforcing bars may need to be designed to develop 125% of the specified yield strength, f_y , of the bars; see applicable building code.

^e See Figure 5.5.



(A) FLARE-BEVEL-GROOVE WELD



(B) FLARE-V-GROOVE WELD

Notes:

1. S = Nominal radius of steel reinforcing bar.
2. E = Effective throat. The throat is the least dimension from the point of fusion in the root to the weld face, less any reinforcement.
3. These are sectional views. Bar deformations are shown only for illustrative purposes.
4. Deformations are not shown for illustration clarity.

Figure 4.1—Effective Throat for Flare-Groove Welds (see 4.2.2)

5. Structural Details

5.1 Transition in Bar Size Number

Direct butt joints in tension in axially aligned bars of different size shall be made as shown in Figure 5.1 (see Annex B for bar size number).

5.2 Joint Types

Steel reinforcing bars may be welded with direct or indirect butt joints, lap joints, or T-joints (Figures 5.1, 5.2, 5.3, 5.4, and 5.5); however, direct butt joints are preferable for bars greater than size No. 6 [19].

5.3 Direct Butt Joints

Table 5.1, Figure 5.2, and Figure 5.5(D) describe the type of welded joints required. For Figure 5.5(D), backgouge to sound metal before welding the other side. For bar size numbers 8 [25] or smaller, the single-bevel weld with backgouging and back welding is recommended.

5.4 Indirect Butt Joints

An indirect butt joint shall be made with either single- or double-flare-groove welds between the bars and the splice member. See Figure 5.3. The welding symbol without S and (E) dimensions indicates the weld shall be filled flush.

5.5 Lap Joints

5.5.1 Direct Lap Joint. A lap joint shall be made with double-flare-V-groove welds [see Figure 5.4(A)], except that single-flare-V-groove welds may be used when the joint is accessible from only one side, and approved by the Engineer.

5.5.2 Indirect Lap Joint. An indirect lap joint shall be made with single flare-bevel groove welds between the bars and the splice plate, with the bars being separated [see Figure 5.4(B)].

5.5.3 Bar Diameter Range. Welded lap joints shall be limited to bar size No. 6 [19] and smaller.

5.5.4 Effects of Eccentricity. The effects of eccentricity shall be considered or restraint provided in the design of the joint.

5.5.5 Filled Flush. The weld symbol without S and (E) dimensions indicates the weld shall be filled flush.

5.6 Lap Joints in an Anchorage

The welding symbol without S and (E) dimensions indicates the weld shall be filled flush [see Figure 5.5(E)].

5.7 Interconnection of Precast Members

Precast members may be interconnected by welding steel reinforcing bars that project through the ends of the precast members or by welding to insert plates that have been cast into the precast members.

Table 5.1
CJP Groove Weld Requirements for Direct Butt Joints (see 5.3)

Bar Axis Orientation	Types of CJP Groove Weld	Figure 5.2 Detail
Horizontal	Single-V	A
	Double-V	B
	Single-V with Split Pipe Backing	C ^a
Vertical	Single-Bevel	D
	Double-Bevel	E
	Single-bevel with Split Pipe Backing	C ^a

^a Bars shall be of equal diameter.

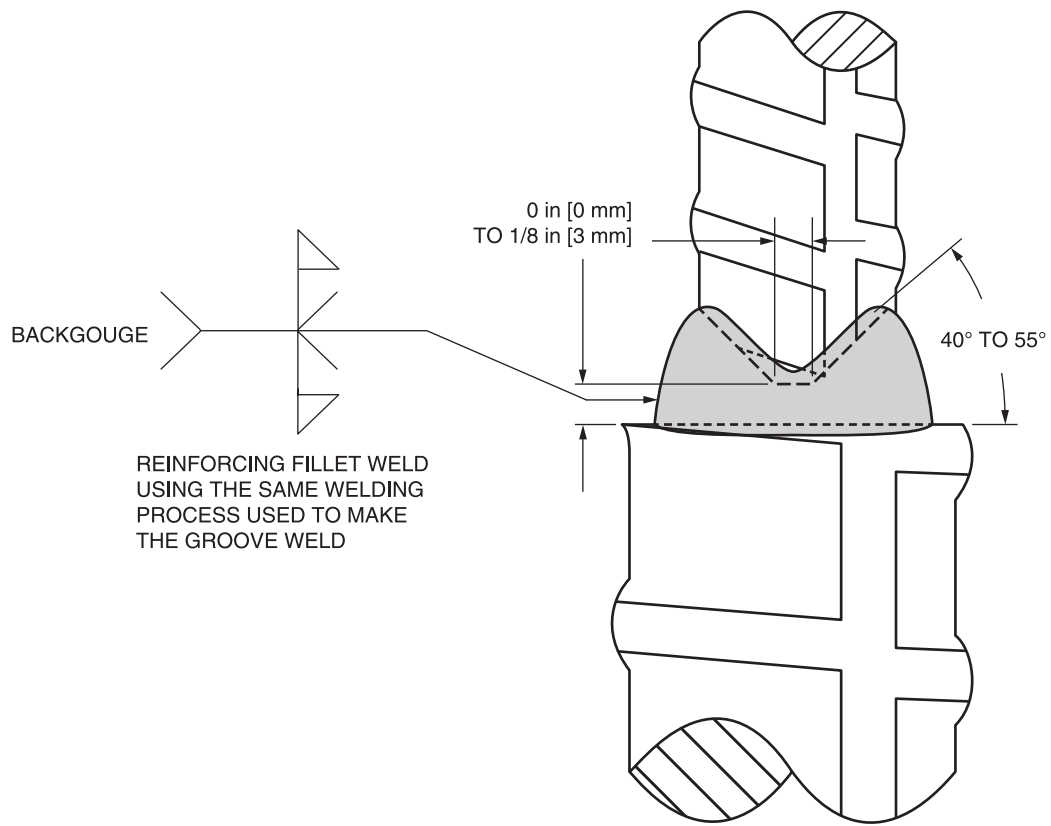


Figure 5.1—Direct Butt Joint Showing Transition Between Bars of Different Sizes (see 5.1)

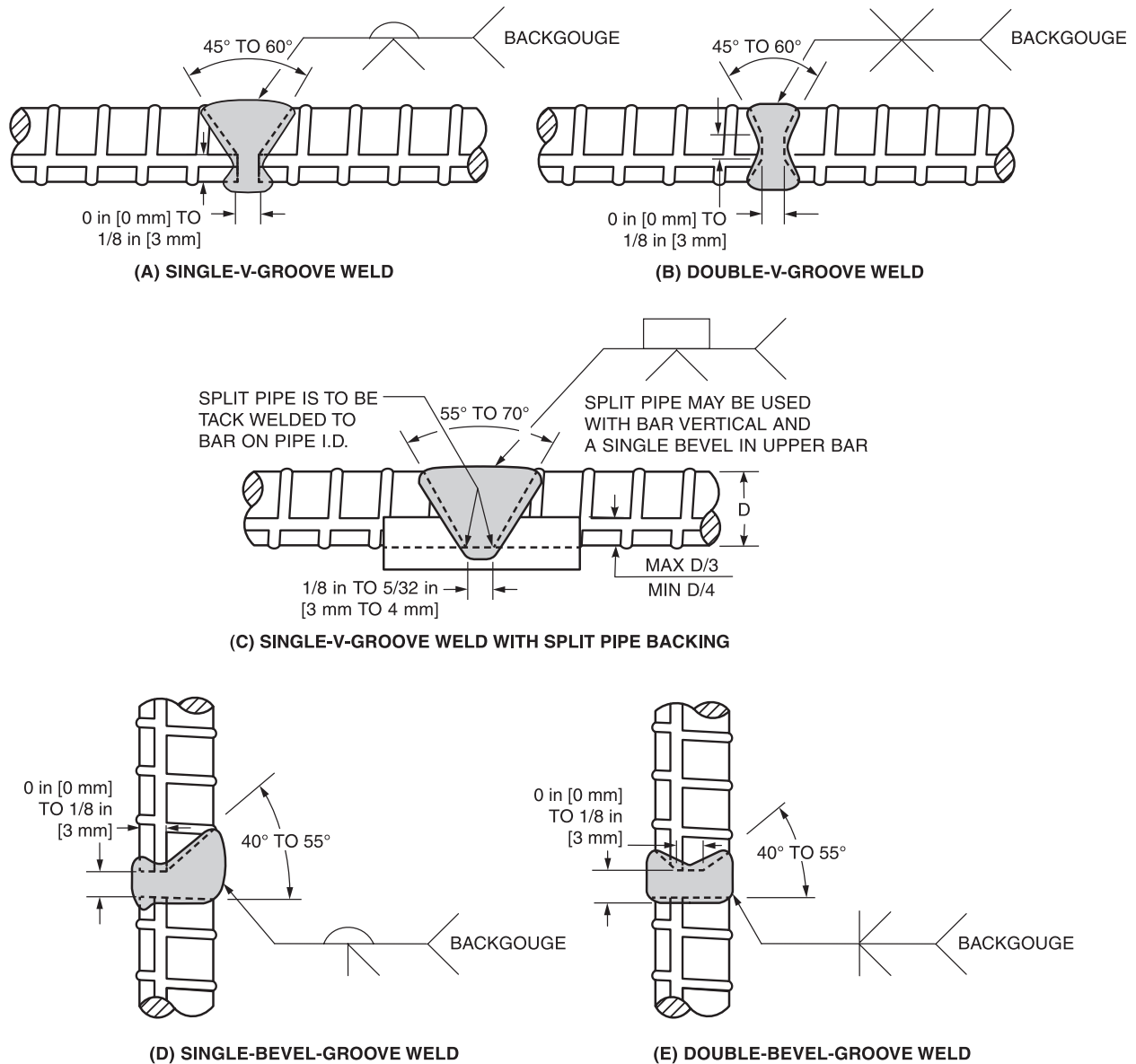
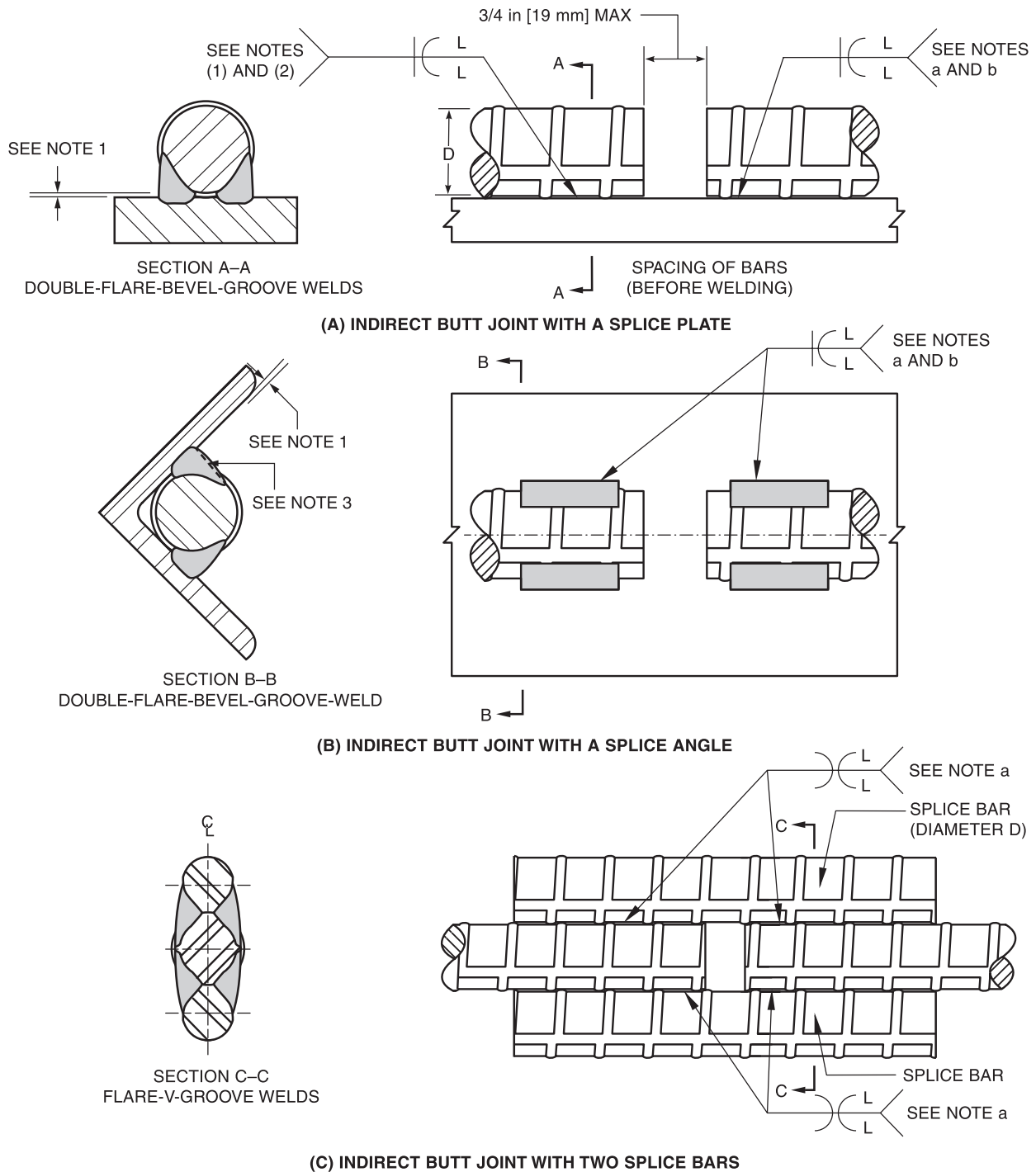


Figure 5.2—Direct Butt Joints (see Table 5.2)



^a $L = 2D$ (min.).

^b Variation of this weld using single flare-V welds is permitted provided eccentricity is considered or restraint provided in the design of the joint.

Notes:

1. Gaps between bars and plate will vary depending on height of deformations but shall not exceed $1/4 D$ or $3/16$ in [5 mm], whichever is less.
2. Deformations shown on sectional views are for illustrative purposes only.
3. Fill flush to bar tangent.

Figure 5.3—Indirect Butt Joints (see 5.4)

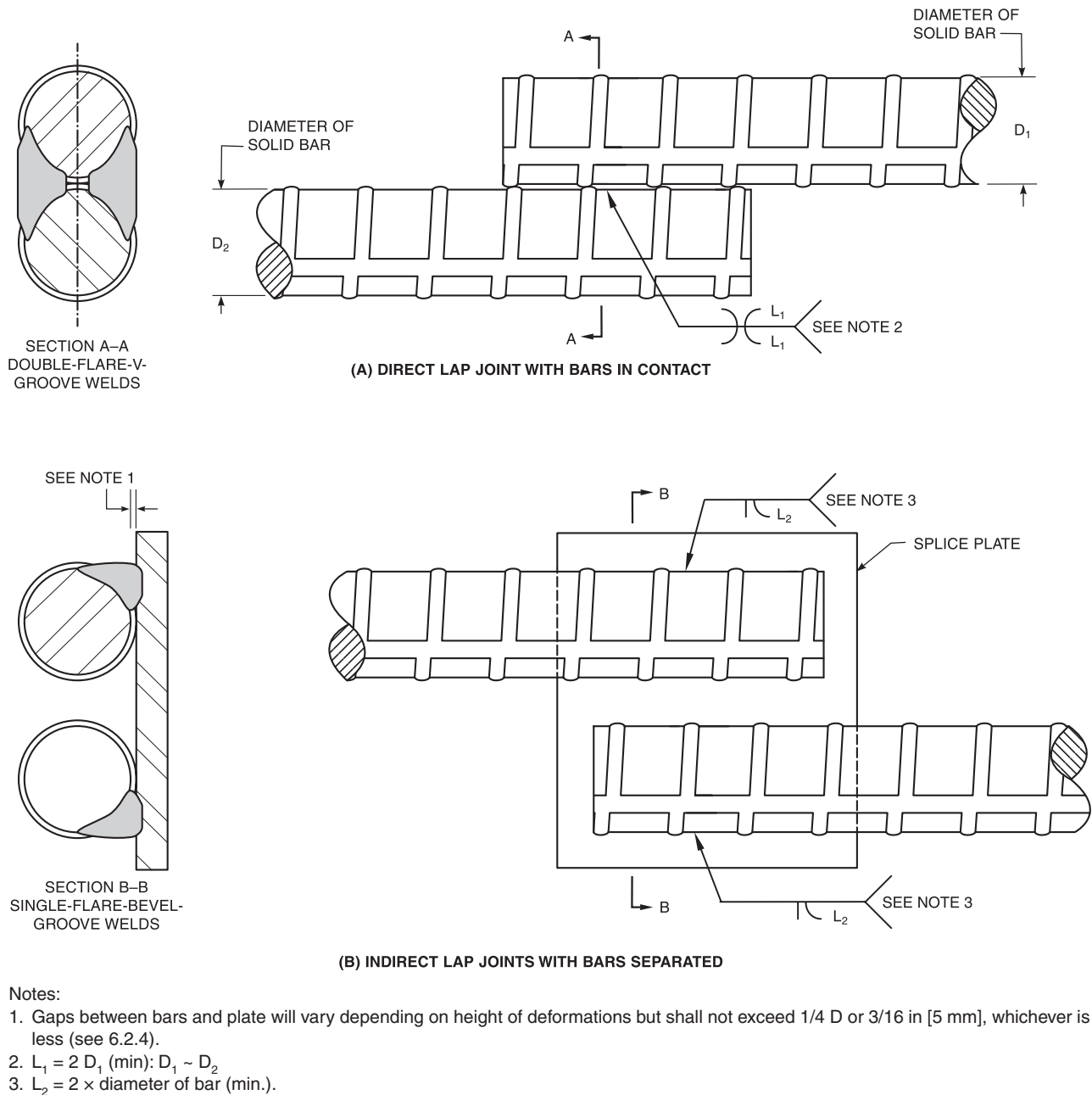
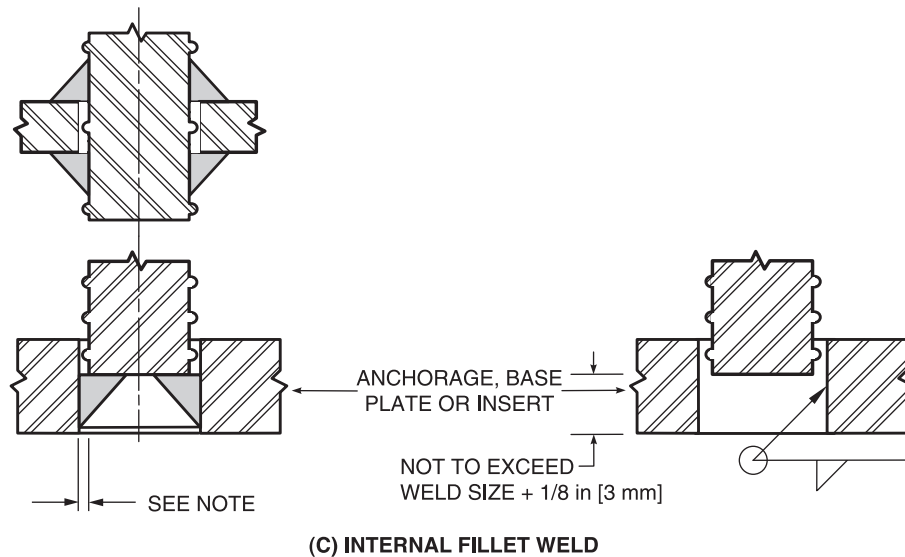
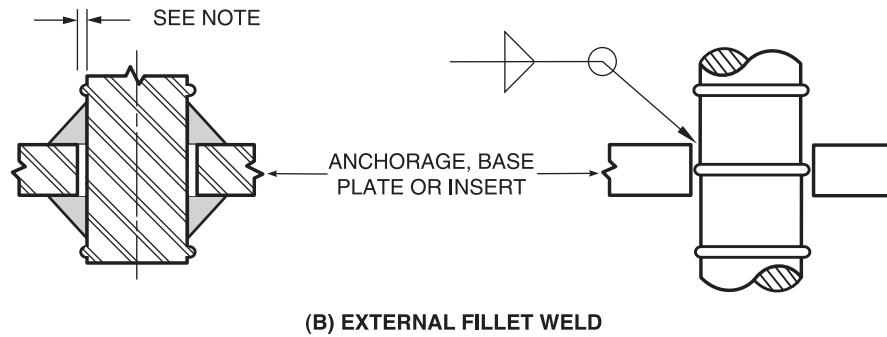
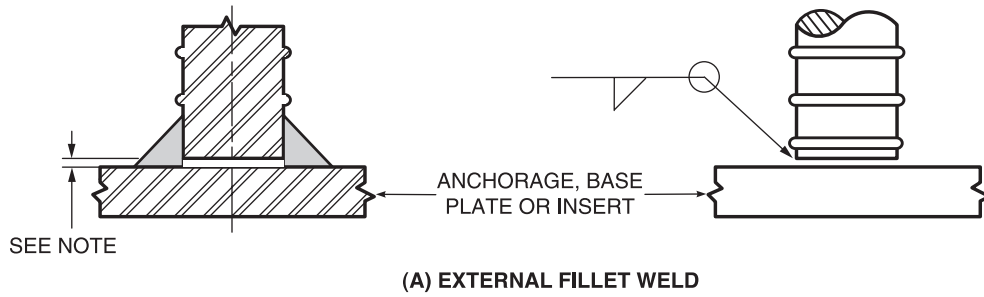


Figure 5.4—Lap Joints (see 5.5.1 and 5.5.2)



Note: Gaps between bars and plate will vary depending on height of deformations but shall not exceed $1/4 D$ or $3/16$ in [5 mm], whichever is less.

Figure 5.5—Details of Joints of Anchorages, Base Plates, and Inserts (see 5.4)