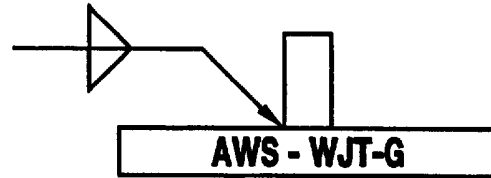
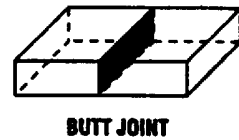
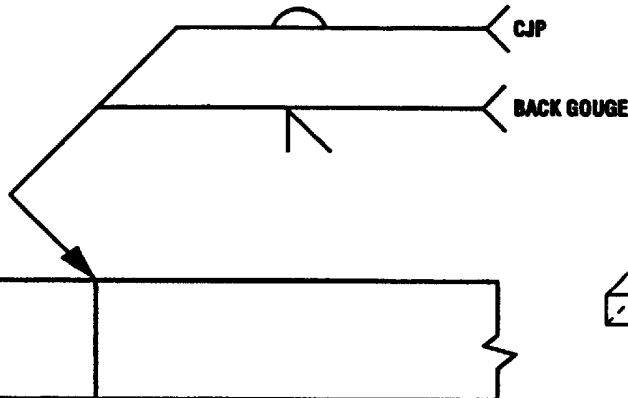
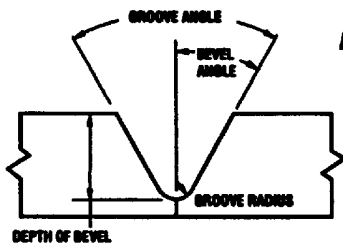


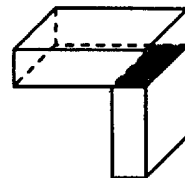
Resource Guide for...



JOINT - WELD TERMINOLOGY and STANDARD WELDING SYMBOLS INTERPRETATION



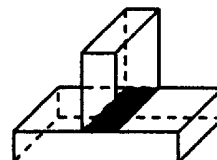
BUTT JOINT



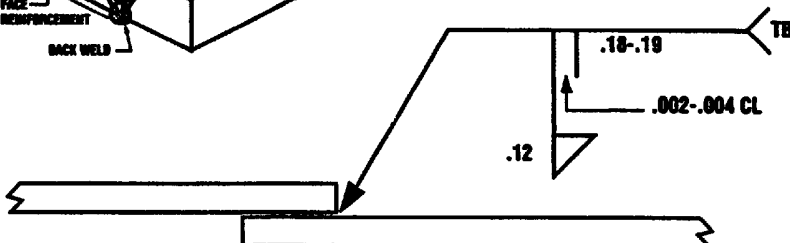
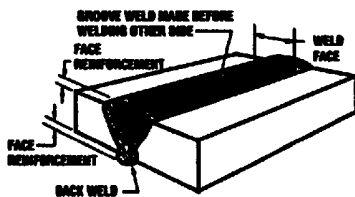
CORNER JOINT



LAP JOINT



T-JOINT



EDGE JOINT



American Welding Society

Resource Guide to . . .

JOINT- WELD TERMINOLOGY AND STANDARD WELDING SYMBOLS INTERPRETATION

First Edition

**Daniel Cantelope, CWI
Education, Training & Development Specialist**

**Published By
American Welding Society
Education Department**

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International Standard Book Number:

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II

FOREWORD

Determinations about joint design and joint selection are part of the design or project engineer's responsibility, as are welding specifications. However, it remains the responsibility of welding personnel to accurately interpret the specifications and to prepare, assemble and join all components during various stages of fabrication.

Knowledge of joint - weld terminology and welding symbol interpretation is essential in everyday welding industry communications. Use of proper terms and the interpretation of welding symbol information makes it easier for welding personnel to relay specifications and solve various design, fitup and welding problems encountered during the course of daily operations.

There is a logical relationship between joint - weld terms and welding symbol information. This training package is designed to provide welding personnel and students with a means to understand the relationship. With self-determination and perseverance, individuals using this training package should come away with valuable knowledge and skills that can be added to their existing skills toolkit.

The *Resource Guide to . . . Joint-Weld Terminology and Welding Symbol Interpretation* has been written for welding personnel seeking to improve personal job communication and their interpretation of welding information found on drawings. The training package partially provides students or trainees with a fundamental knowledge of some of the language used in the welding industry and is a basis to further pursue drawing interpretation.

The templates used in this training package are based on information found in two American Welding Society standards. The first, ANSI/AWS A3.0, *Standard Welding Terms and Definitions*, was used to build text, provide terminology and show illustrations relevant to the preparation and welding of workpieces before, during and after fabrication. Upon completion of this portion of training, the student should begin to recognize the relationship between terms associated with parts of a joint and the parts of a weld. In addition, a basis is formed to recognize the relationship between joint construction and the appearance of the graphical representation of a weld (the weld symbol). Armed with this associated terminology, a bridge is formed from which the student can make the transition to welding symbol interpretation. The second document, ANSI/AWS A2.4, *Standard Symbols for Welding Brazing and Nondestructive Examination*, was used to provide text, terminology and illustrations relevant to the recognition and interpretation of a welding symbol. This portion of training explores weld and welding symbol basics, before introducing students to the supplementary data and dimensioning that makes welding symbols the "shorthand" of the welding industry. All learning activities in this package are coupled with review exercises designed to measure the student's knowledge of the concepts presented. This package can be used as a home study course, for personal enrichment, or may be delivered as a group workshop or class in an industrial training or educational setting.

Daniel Cantelope, Author
CWI, Education Training & Development Specialist

TABLE OF CONTENTS

Foreword	.iii
Program Introduction	.vii - x
Purpose	.vii
Contents	.vii
Learning Objectives	.viii
Directions	.viii
Completion Sequence	.ix
Learning Activities	.1 - 150
<i>Learning Activity 1 - Welded Joint Terminology</i>	.1 - 23
Terms and Definitions	.16
Review 1	.19
<i>Learning Activity 2 - Weld Terminology</i>	.25 - 48
Terms and Definitions	.39
Review 2	.43
<i>Learning Activity 3 - Welding Symbol Basics</i>	.49 - 66
Review 3	.63
<i>Learning Activity 4- Welding Symbol Dimensioning and Supplementary Data</i>	.67- 145
Review 4A - Fillet Weld Symbol	.127
Review 4B - Plug and Slot Weld Symbols	.129
Review 4C - Spot and Projection Weld Symbols	.131
Review 4D - Seam Weld Symbol	.133
Review 4E - Stud Weld Symbol	.135
Review 4F - Surfacing Weld Symbol	.137
Review 4G - Back or Backing Weld Symbols	.139
Review 4H - Flange Weld Symbols	.141
Review 4I - Groove Weld Symbols	.143

PROGRAM INTRODUCTION

PURPOSE

The training package developed for *Joint - Weld Terminology and Welding Symbols Interpretation*, was assembled to provide students with valuable tools that can be added to their existing skills toolkit. Knowledge of joint - weld terminology and welding symbols interpretation improves job skills in several ways:

- Welding industry personnel can communicate in terms that clearly convey joint and weld information.
- Knowledge of joint-weld terms may help reduce the amount of waste that is often the result of miscommunications.
- Knowledge of joint-weld terms helps welding personnel envision various components of a joint and the parts of a weld. This leads to a better understanding of the weld symbol and the interpretation of dimensions and supplementary data associated with a welding symbol.
- Use of welding symbols on drawings allows designers or draftsmen to convey accurate joint and welding information in most cases without having to provide additional views for a particular zone.
- Welding symbols allow welding personnel to envision joint and weld requirements quicker than having to constantly refer to numerous detailed drawings during all phases of fabrication.

CONTENTS

Within the instructional package all users will find:

- Resource Guide
 - Reading Assignments and Reviews
 - Answer Key (for users not participating in home study or seminars)

In addition, correspondence course (home study) and AWS seminar users will receive:

- Related Information Test Booklet
 - Scantron Test Scoring Sheet
- ANSI/AWS A2.4 - Standard Symbols for Welding, Brazing and Nondestructive Examination
- ANSI/AWS A3.0 - Standard Welding Terms and Definitions

LEARNING OBJECTIVES

Upon completion of instruction the student should be able to:

- Recognize basic, flanged and spliced joint designs.
- Relate joint terminology to the appearance of various components of welded joints.
- Recognize the relationship between joint design and weld symbol construction.
- Relate joint design to weld requirements.
- Relate weld terminology to the appearance of various parts of a weld.
- Recognize the appearance of basic weld and supplementary symbols.
- Interpret the meaning of basic weld and supplementary symbols.
- Relate joint - weld terminology to supplementary dimensioning and data associated with welding symbol information.
- Interpret welding symbol information related to joint design and welding requirements.

DIRECTIONS

This training package is organized into three parts, *Learning Activities*, *Reviews*, and a *Related Information Test*.

- Learning Activities require participants to read the contents of each topic presented.
- Reviews are completed in three ways:
 1. AWS correspondence course users complete each review when requested to do so and submit the completed test to the AWS Education Department, Attn: Home Study.
 2. AWS group workshop participants complete each review after presentation of the major concept associated with it.
 3. Self-study participants should complete each review after reading the major concept associated with it, check each answer against the answer sheet, and review any subject matter area answered incorrectly.
- The Related Information Test serves two purposes:
 1. A final examination for individuals participating in the AWS correspondence course.
 2. A final self-examination for individuals participating in an AWS group workshop.

Note: The related information test is not included when the training package is purchased for self-study.

Completion Sequence (AWS Correspondence Course)

Learning Activity 1 - Joint Terminology

- **Read/Review** . .Joint Terminology - text and illustrations, pages 1 - 15
- **Study** Terms and Definitions, pages 16 - 17
- **Complete** Review 1 “Joint Terminology,” pages 19 - 23
- **Mail** Review 1 “Joint Terminology” to address listed at the end of this section

Learning Activity 2 - Weld Terminology

- **Read/Review** . .Weld Terminology, text and illustrations, pages 25 - 38
- **Study** Terms and Definitions, pages 39 - 42
- **Complete** Review 2 “Weld Terminology,” pages 43 - 48
- **Mail** Review to address listed at the end of this section

Learning Activity 3 - Welding Symbol Basics

- **Read/Review** . .Welding Symbol Basics, text and illustrations, pages 49 - 62
- **Complete** Review 3 “Welding Symbol Basics,” pages 63 - 66
- **Mail** Review to address listed at the end of this section

Learning Activity 4 - Welding Symbol Dimensioning and Supplementary Data

- **Read/Review** . .Introduction and Fillet Welds, text and illustrations, pages 67 - 72
- **Complete** Review 4A “Fillet Weld Symbol,” pages 127 - 128
- **Mail** Review to address listed at the end of this section

- **Read/Review** . .Plug and Slot Welds, text and illustrations, pages 73 - 79
- **Complete** Review 4B “Plug and Slot Weld Symbols,” pages 129 - 130
- **Mail** Review 4B “Plug and Slot Weld Symbols to address listed at the end of this section

- **Read/Review** . .Spot and Projection Weld Symbols, text and illustrations, pages 80 - 86
- **Complete** Review 4C “Spot and Projection Weld Symbols,” pages 131 - 132
- **Mail** Review to address listed at the end of this section

- **Read/Review** . .Seam Weld, text and illustrations, pages 87 - 92
- **Complete** Review 4D “Seam Weld Symbol,” pages 133 - 134.
- **Mail** Review to address listed at the end of this section

- **Read/Review** . .Stud Weld, text and illustrations, page 93
- **Complete** Review 4E “Stud Weld Symbol,” pages 135 - 136
- **Mail** Review to address listed at the end of this section

(continued ➡)

- **Read/Review** . .Surfacing Weld, text and illustrations, pages 94 - 95
- **Complete** Review 4F “Surfacing Weld Symbol,” pages 137 - 138
- **Mail** Review to address listed at the end of this section

- **Read/Review** . .Back or Backing Welds, text and illustrations, pages 96 - 97
- **Complete** Review 4G “Back or Backing Weld Symbols,” page 139
- **Mail** Review to address listed at the end of this section

- **Read/Review** - Flange Weld, text and illustrations, pages 98 - 101
- ***Complete** - Review 4H “Flange Weld Symbols,” pages 141 - 142
- **Mail** Review to address listed at the end of this section

- **Read/Review** . .Groove Welds, text and illustrations, pages 102 - 125
- ***Complete** Review 4I “Groove Weld Symbols,” pages 143 - 145
- **Mail** Review to address listed at the end of this section.

Related Information Test

- **Read/Review** . .Directions, in the related information test booklet
- **Complete** Identifying information on the related information scoring sheet.
- **Complete**“Related Information Test,” (found in the test booklet).
- **Mail** Test to address listed at the end of this section

*Return Mailing and Technical Support

Upon Completion of each review, remove the test from the resource guide, place it in an envelope and forward it for scoring to:

American Welding Society
550 N. W. LeJeune Road
Miami, Florida, 33136

Attention: Education Department - Home Study

Correspondence Course participants may receive technical support by telephoning the AWS Education Department at the following number

1-800-443-9353

x

Learning Activity 1:

WELDED JOINT TERMINOLOGY

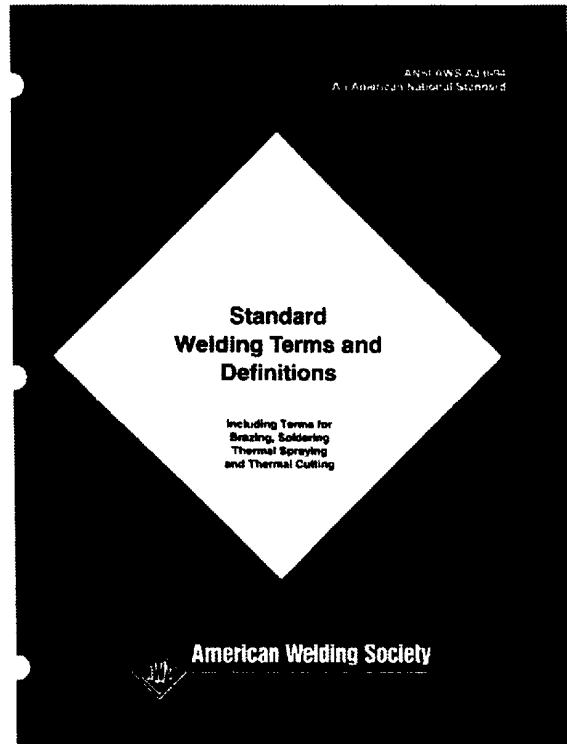
Determinations made about welding specifications are part of the design or project engineer's responsibility, as are joint design and joint selection. However, it is still the responsibility of fabrication personnel to accurately interpret joint information and prepare it for fabrication. Knowledge of welded joint terminology is essential in every day job communication. Use of proper terms makes it easier for welding personnel to relay various fitup and welding problems encountered during the fabrication process to other personnel involved. There is a direct relationship between welded joint terms and supplementary welding symbol data and dimensioning.

WELDED JOINTS

There are five basic joints used in welded metal fabrication: *butt, corner, tee, lap* and *edge*. As illustrated in Figure 1.1, page 2, certain welds and weld symbols are applicable to the five basic joint designs. A number of different welds can be applied to each type of joint depending upon the joint design. *Joint design* identifies, "the shape, dimensions, and configuration of the joint."

In the 1994 revision of ANSI/AWS A3.0, *Standard Terms and Definitions*, additional joint classifications for *flanged joints* and *spliced joints* were added. Flanged joints, Figure 1.2, are formed into one of the five basic joint types in which at least one of the joint members has a flanged edge shape at the weld joint. A *spliced joint* is, "a joint in which an additional workpiece spans the joint and is welded to each joint member," Figure 1.3

The individual workpieces of a joint are called *members*. Members are classified in three ways: *butting members*, *nonbutting members* or *splice*

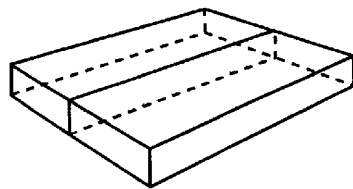


members. Figures 1.3 and 1.4 provide illustrations of each type of member.

A *butting member* is, "a joint member that is prevented, by the other member, from movement in one direction perpendicular to its thickness dimension. For example, both members of a butt joint, or one member of a T-joint or corner joint."

A *nonbutting member* is, "a joint member that is free to move in a direction perpendicular to its thickness dimension. For example, both members of a lap joint, or one member of a T-joint or corner joint."

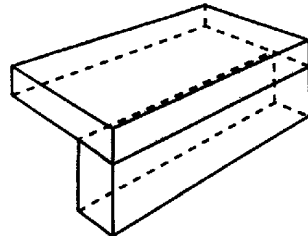
A *splice member* is, "the workpiece that spans the joint in a spliced joint." In Figure 1.3 two examples are provided for splices used in connection with butt joints.



(A) BUTT JOINT

APPLICABLE WELDS and WELD SYMBOL

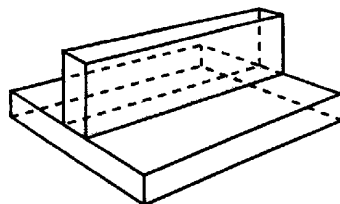
	Bevel-Groove		U-Groove
	Flare-Bevel-Groove		V-Groove
	Flare-V-Groove		Edge-Flange
	J-Groove		Scarf (for braze joint)
	Square-Groove		



(B) CORNER JOINT

APPLICABLE WELDS and WELD SYMBOL

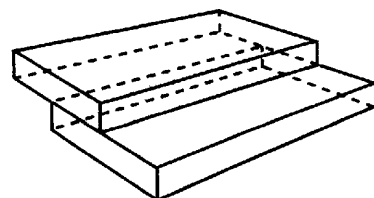
	Fillet		Corner-Flange
	Bevel-Groove		Edge-Flange
	Flare-Bevel-Groove		Plug
	Flare-V-Groove		Slot
	J-Groove		Spot
	Square-Groove		Seam
	U-Groove		Projection
	V-Groove		



(C) T-JOINT

APPLICABLE WELDS and WELD SYMBOL

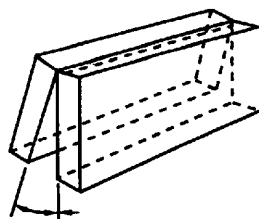
	Fillet		Slot
	Bevel-Groove		Spot
	Flare-V-Groove		Seam
	J-Groove		Projection
	Square-Groove		
	Plug		



(D) LAP JOINT

APPLICABLE WELDS and WELD SYMBOL

	Fillet		Slot
	Bevel-Groove		Spot
	Flare-V-Groove		Seam
	J-Groove		Projection
	Square-Groove		*Braze
	Plug		

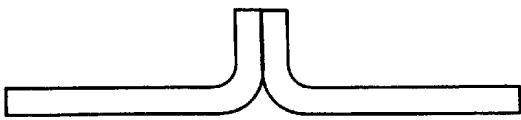


(E) EDGE JOINT

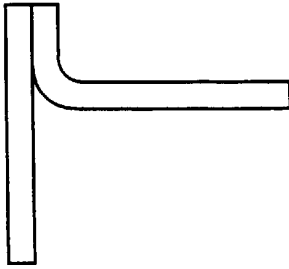
APPLICABLE WELDS and WELD SYMBOL

	Bevel-Groove		V-Groove
	Flare-Bevel-Groove		Edge
	Flare-V-Groove		Corner-Flange
	J-Groove		Edge-Flange
	Square-Groove		Seam
	U-Groove		

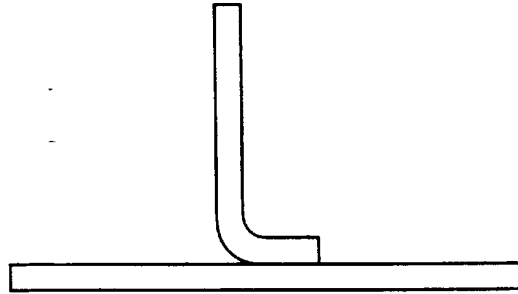
Fig. 1.1 - The five basic types of joints and welds applicable to each. Applicable welds are determined by the combinations of edge or surface preparations of each member used in the design of each joint (refer to fig 1.5). Weld symbols resemble the joint groove when viewed in cross section (refer to figs 1.6 - 1.10).



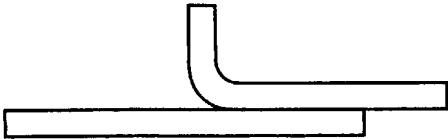
(A) FLANGED BUTT JOINTS



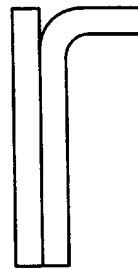
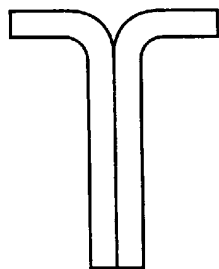
(B) FLANGED CORNER JOINT



(C) FLANGED T-JOINT

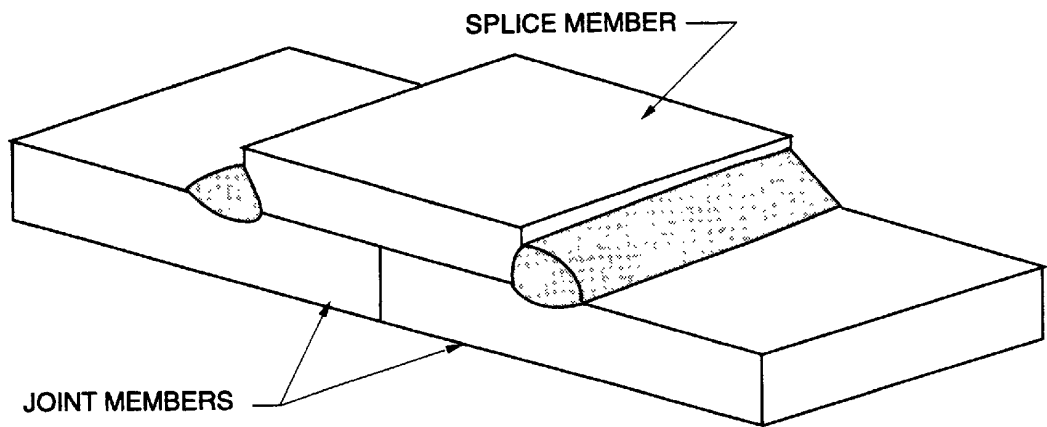


(D) FLANGED LAP JOINTS

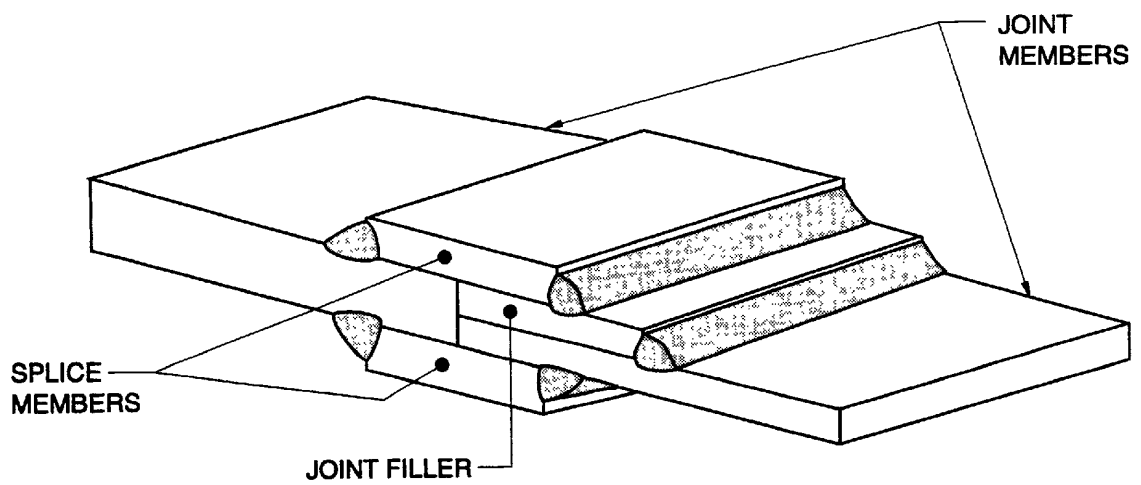


(E) FLANGED EDGE JOINTS

Figure 1.2 - Flanged Joints



(A) SINGLE-SPLICED BUTT JOINT



(B) DOUBLE-SPLICED BUTT JOINT WITH JOINT FILLER

Figure 1.3 - Spliced Butt Joints

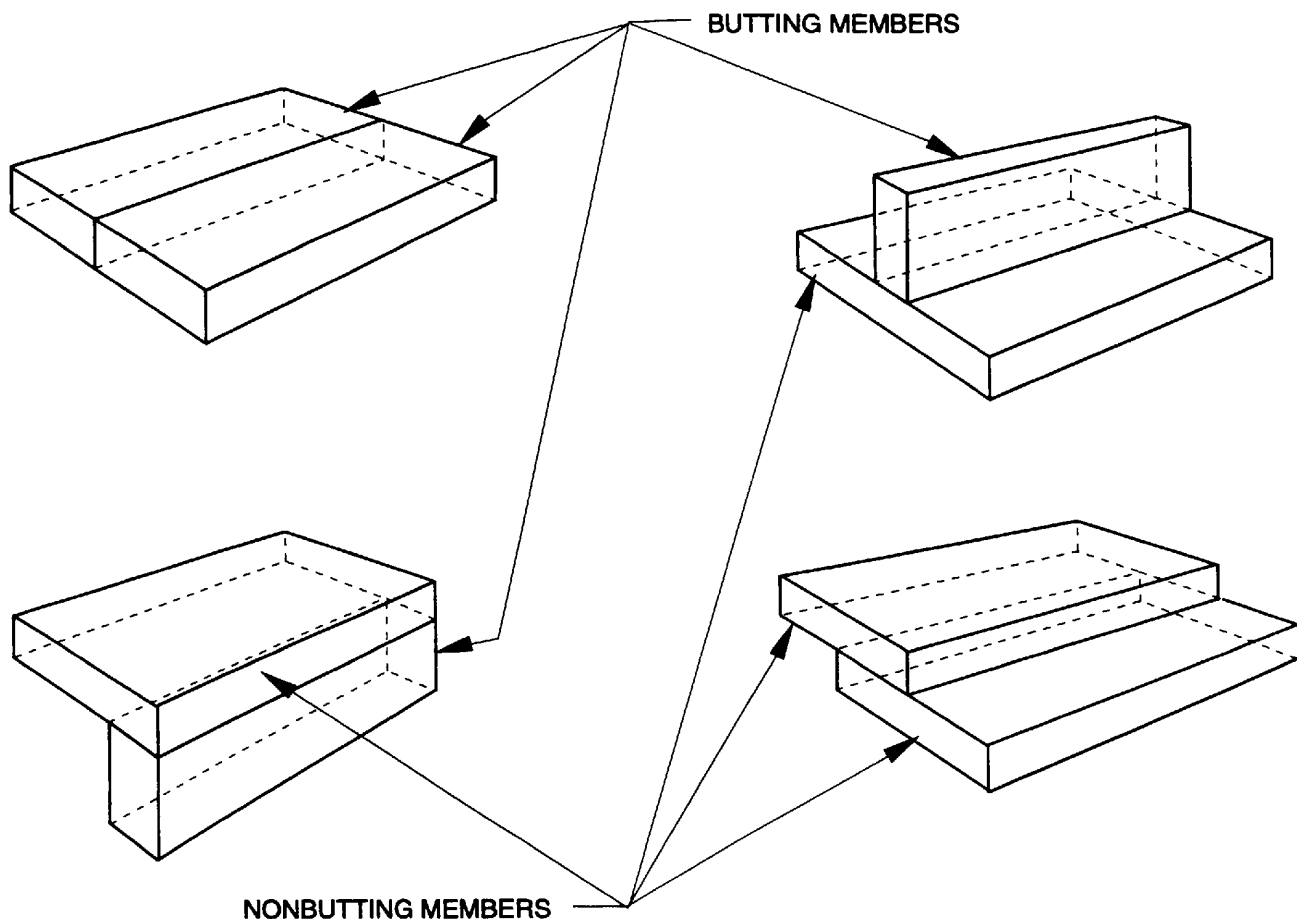


Figure 1.4 - Butting and Nonbutting Members

Identification of the weld type is indicated in the joint geometry. *Joint geometry* is “the shape and dimensions of a joint in cross section prior to welding.” When a joint is viewed in cross section, the *edge shape* of each mating member often resembles the weld type and weld symbol specified. Figure 1.5 identifies basic edge shapes used in welded metal fabrication and the welds applicable to each. The cross sectional views provided in Figures 1.6 through 1.10 show the

relationship between weld symbol appearance and combinations of various edge shapes. These combinations of different edge shapes illustrate a variety of joint configurations for some of the applicable welds identified in the five basic joint arrangements shown in Figure 1.1. Many more weld types and groove designs can be made using various structural or formed shapes when applicable edge or surface preparations are applied to them.



(A) SQUARE EDGE SHAPE



(B) SINGLE-BEVEL EDGE SHAPE



(C) DOUBLE-BEVEL EDGE SHAPE



(D) SINGLE-J-GROOVE EDGE SHAPE



(E) DOUBLE-J-GROOVE EDGE SHAPE



(F) FLANGE EDGE SHAPE



(G) ROUND EDGE SHAPE

APPLICABLE WELDS

Double-Bevel-Groove	Single-J-Groove
Double-Bevel-Flare-Groove	Square-Groove
Double-J-Groove	Edge
Single-Bevel-Groove	Fillet
Single-Flare-Bevel-Groove	

APPLICABLE WELDS

Single-Bevel-Groove
Single-V-Groove

APPLICABLE WELDS

Double-Bevel-Groove
Double-V-Groove

APPLICABLE WELDS

Single-J-Groove
Single-U-Groove

APPLICABLE WELDS

Double-J-Groove
Double-U-Groove

APPLICABLE WELDS

Double-Flare-Bevel-Groove	Projection
Single-Flare-V-Groove	Seam
Edge	Spot
Fillet	

APPLICABLE WELDS

Double-Flare-Bevel-Groove
Double-Flare-V-Groove

Figure 1.5 - Edge Shapes. The edge shapes shown above are used in combinations to form any of the five basic joint arrangements in figure 1.1. The result of these combinations is a weld groove. When the formed joint is viewed in cross section the weld groove resembles the weld symbol for an applicable weld. One line (or one half) of each weld symbol would represent the edge shape for one of the mating members of a joint's weld groove. This concept is illustrated in figures 1.6 through 1.10.

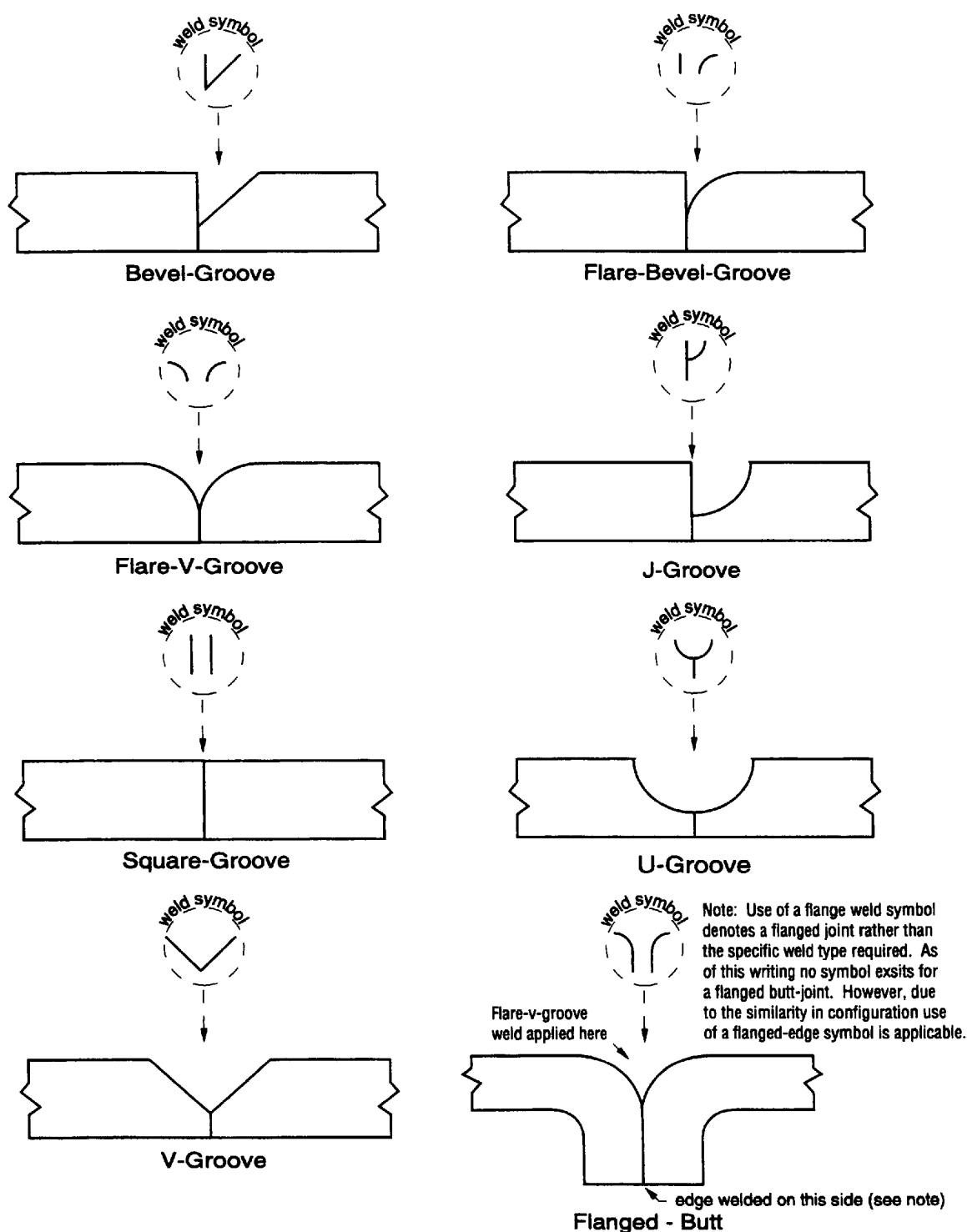


Figure 1.6 - Edge shape combinations for Butt Joint variations. The cross sectional views above show similarity of the weld groove to a particular weld symbol, and indicate the type of weld that is used to fill the groove. Each line of a weld symbol represents the edge shape of one joint member when the weld groove (or area) is viewed in cross section. This does not mean the weld symbol would be rotated to conform to the orientation of the joint; instead, the symbol represents the combined edge shape or surface preparation of each member.

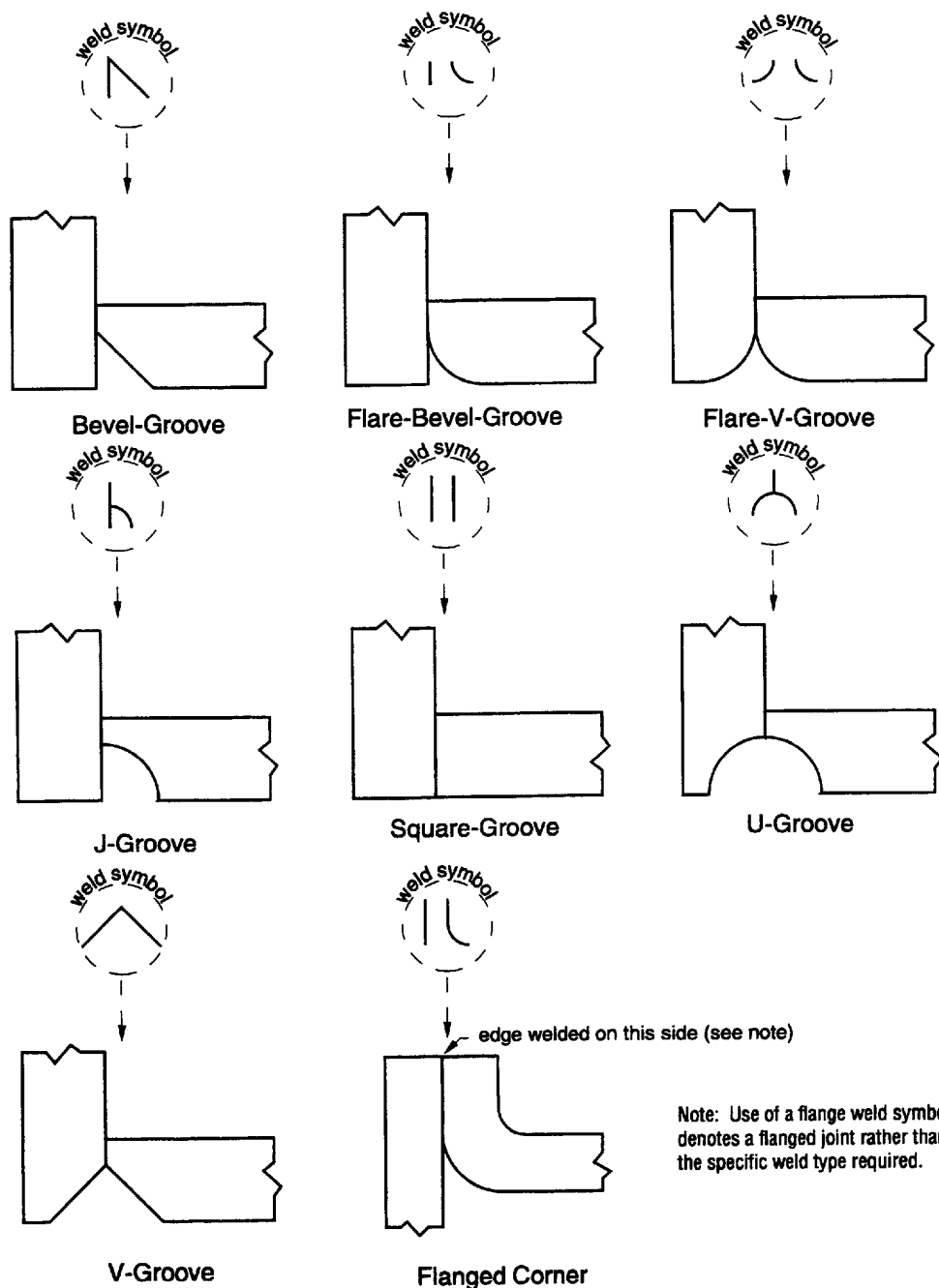


Figure 1.7 - Edge shape combinations for Corner Joint variations. The cross sectional views above show similarity of the weld groove to a particular weld symbol, and indicate the type of weld that is used to fill the groove. Each line of a weld symbol represents the edge shape of one joint member when the weld groove (or area) is viewed in cross section. This does not mean the weld symbol would be rotated to conform to the orientation of the joint; instead, the symbol represents the combined edge shape or surface preparation for each member. Surface preparations for plug, slot, spot and projection welds can be made to the square groove and flanged corner configurations to accommodate these types of welds. Fillet and seam welds can also apply to several of the joints.

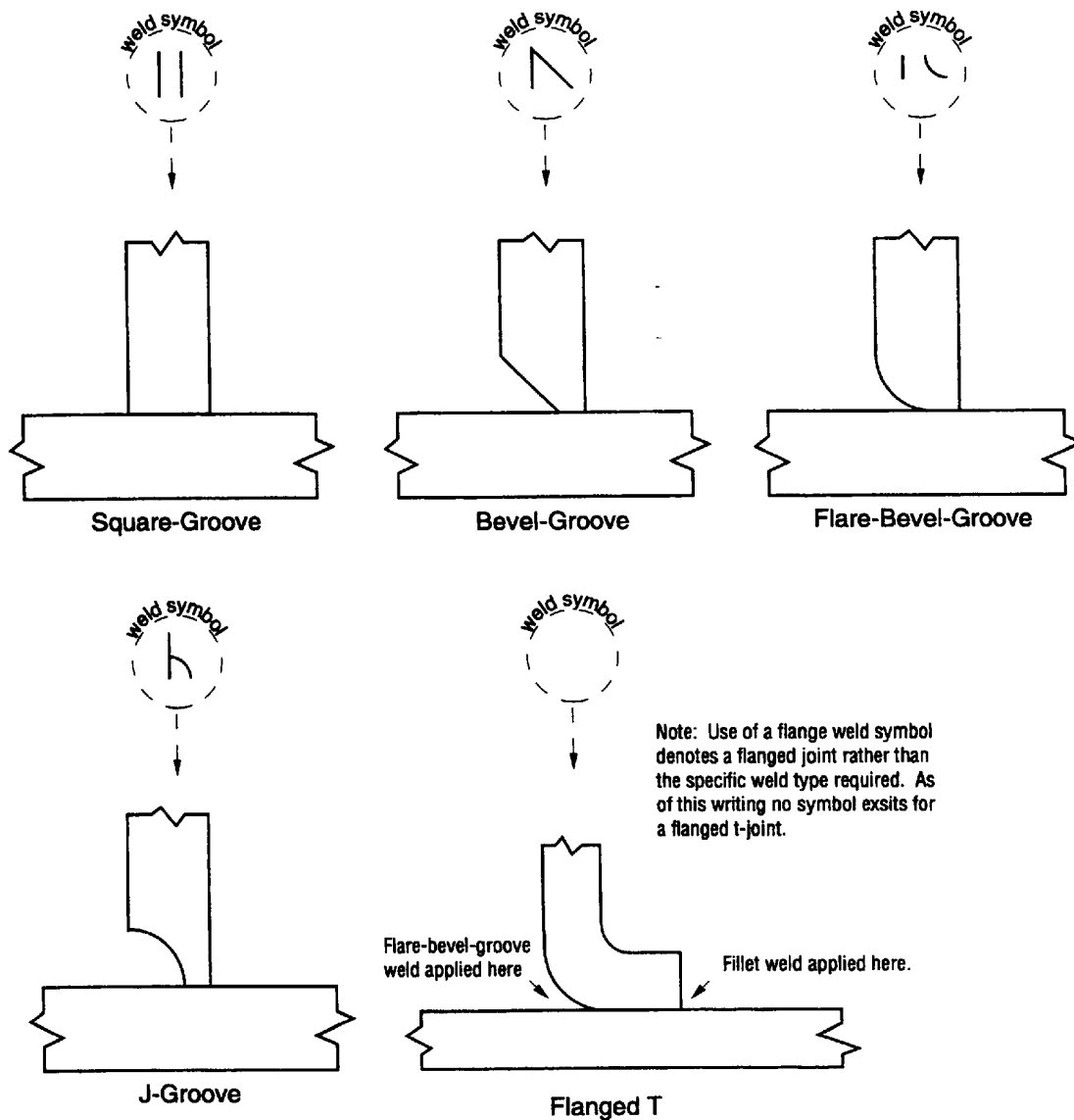


Figure 1.8 - Edge shape combinations for T Joint variations. The cross sectional views above show similarity of the weld groove to a particular weld symbol, and indicate the type of weld that is used to fill the groove. Each line of a weld symbol represents the edge shape of one joint member when the weld groove (or area) is viewed in cross section. This does not mean the weld symbol would be rotated to conform to the orientation of the joint; instead, the symbol represents the combined edge shape or surface preparation for each member. Surface preparations for plug, slot, spot and projection welds can be made to the square groove and flanged corner configurations to accommodate these types of welds. Fillet and seam welds can also apply to several of the joints.

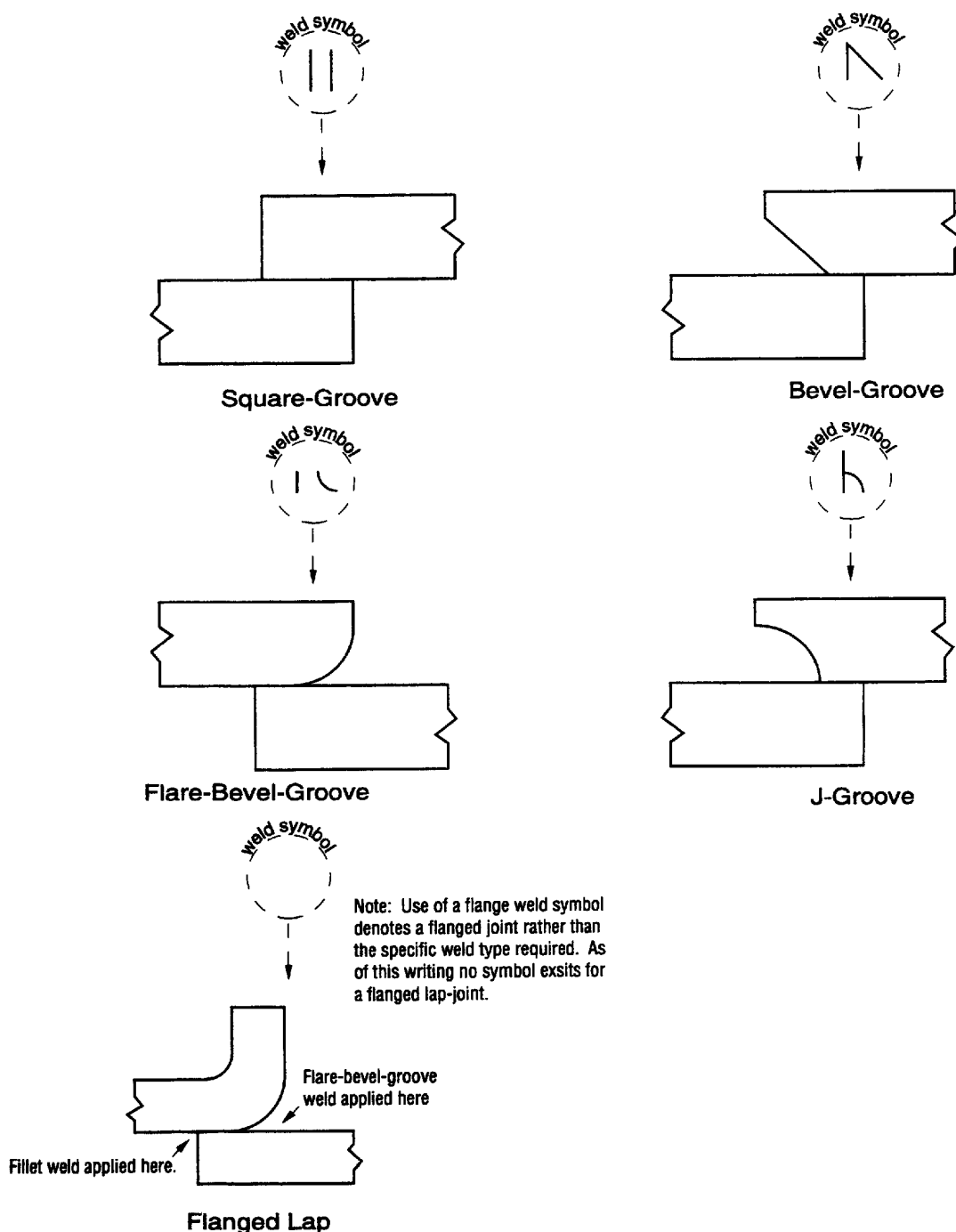


Figure 1.9 - Edge shape combinations for Lap Joint variations. The cross sectional views above show similarity of the weld groove to a particular weld symbol, and indicate the type of weld that is used to fill the groove. Each line of a weld symbol represents the edge shape of one joint member when the weld groove (or area) is viewed in cross section. This does not mean the weld symbol would be rotated to conform to the orientation of the joint; instead, the symbol represents the combined edge shape or surface preparation of each member. Surface preparations for plug, slot, spot and projection welds can be made to several of the configurations to accommodate these types of welds. Fillet and seam welds can also apply to several of the joints.

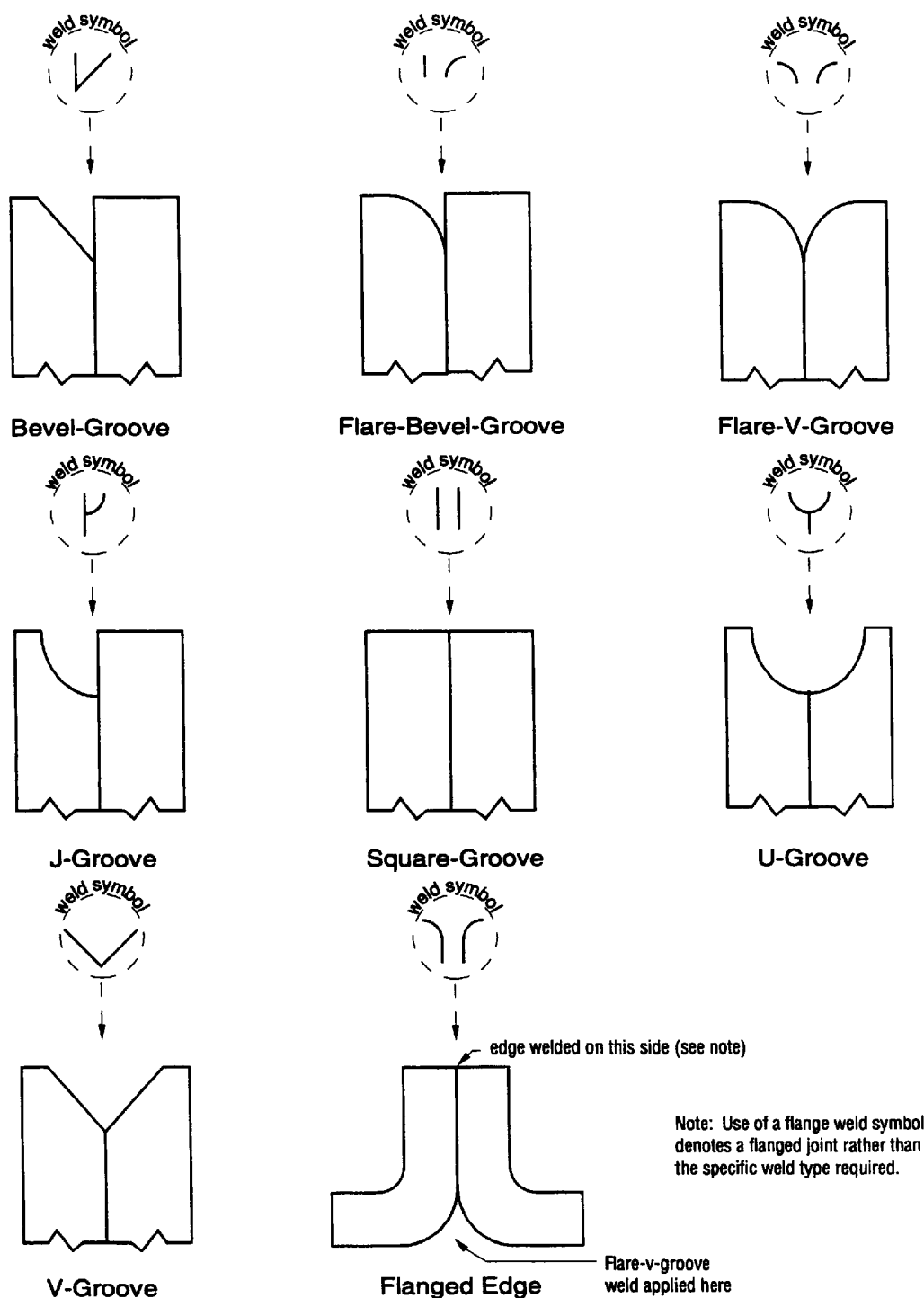


Figure 1.10 - Edge shape combinations for Edge Joint variations. The cross sectional views above show similarity of the weld groove to a particular weld symbol, and indicate the type of weld that is used to fill the groove. Each line of a weld symbol represents the edge shape of one joint member when the weld groove (or area) is viewed in cross section. This does not mean the weld symbol would be rotated to conform to the orientation of the joint; instead, the symbol represents the combined edge shape or surface preparation for each member. Edge and seam welds can also apply to several of the joints.

Parts of the Weld Joint

Once the type of joint is identified, it may be necessary to describe the exact joint design required. To do this, welding personnel must be capable of identifying individual features that make up the joint geometry for a particular joint. The nomenclature associated with these features include:

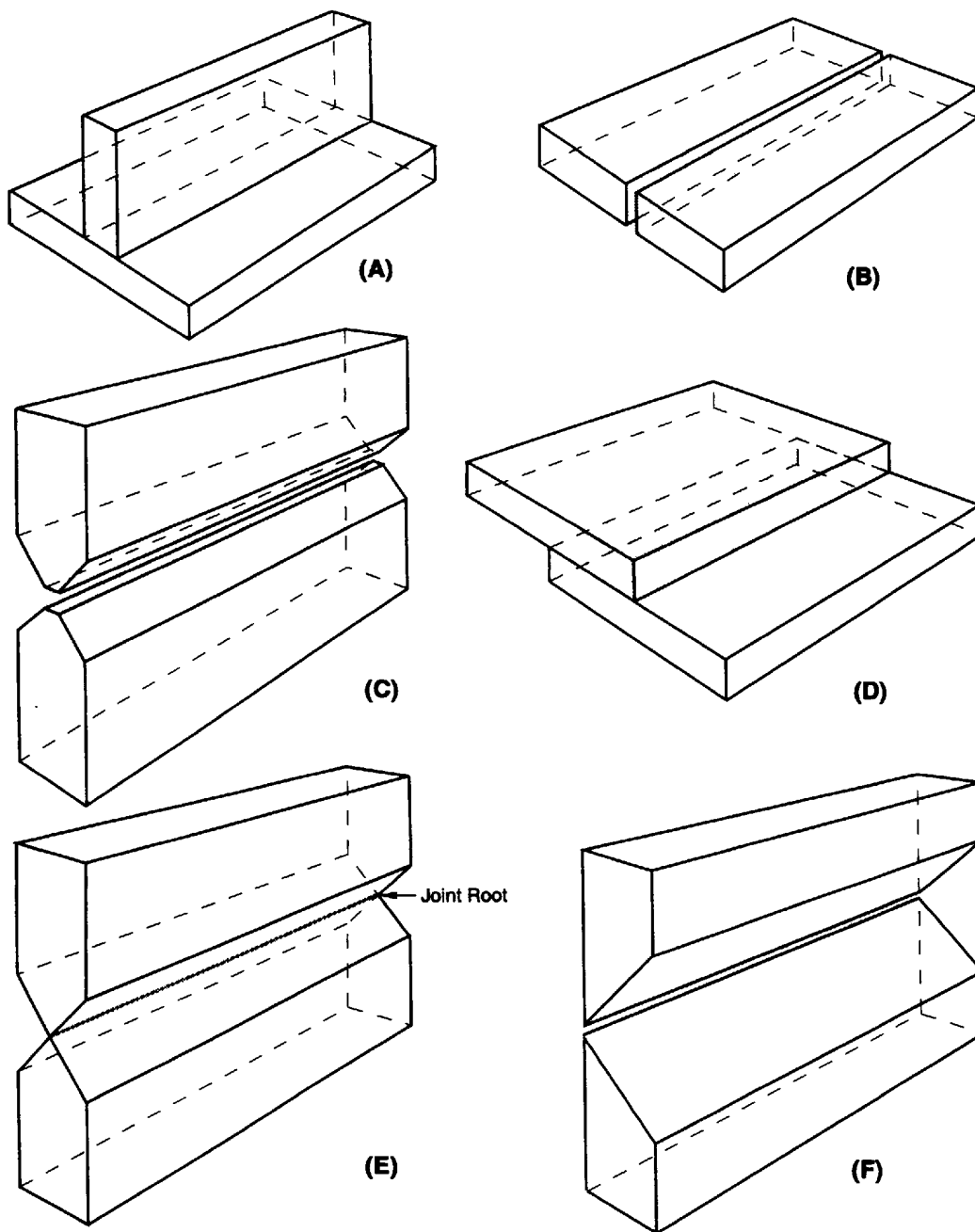
- joint root
- groove face
- root face
- root edge
- root opening
- bevel
- bevel angle
- groove angle
- groove radius.

Depending upon the particular type of joint design, the joint geometry may take on slightly different shapes. One example is the *joint root*. Joint root is defined as, “that portion of a joint to be welded where the members approach closest to each other. In cross section, the joint root may be either a point, line, or an area.” Figure 1.11 illustrates some of the variations in the joint root for several different joint designs. In each case, the joint root is shown as a shaded area of the sketch.

The nomenclature associated with groove face, root face and root edge is identified in Figure 1.12, page 14. *Groove face* is, “that surface of a member included in the groove.” The *root face* (commonly called the land, nose or flat) is “that portion of the groove face within the joint root.” Finally, *root edge* is defined as “a root face of zero width.

Other features that may require description by welding personnel are shown in Figure 1.13. These elements are often the essential variables in welding procedures, and welding personnel may be required to actually measure them to determine their compliance with applicable drawings or other documents.

The *root opening* is described as “the separation between the workpieces at the joint root.” The *bevel* (also commonly referred to as the chamfer) is “an angular edge preparation.” *Bevel angle* is defined as “the angle between the bevel of a joint member and a plane perpendicular to the surface of the member.” *Groove angle* is, “the total included angle of the groove between workpieces.” For a single-bevel-groove-weld, the bevel angle and the groove angle are equal. *Groove radius*, applies only to J- and U-groove-welds. It is described as “the radius used to form the shape of a J- or U-groove weld.” Normally, a J- or U-groove weld configuration is specified by both a bevel (or groove) angle and a groove radius.



NOTE: Joint root is denoted by shading

Figure 1.11 - Joint Root

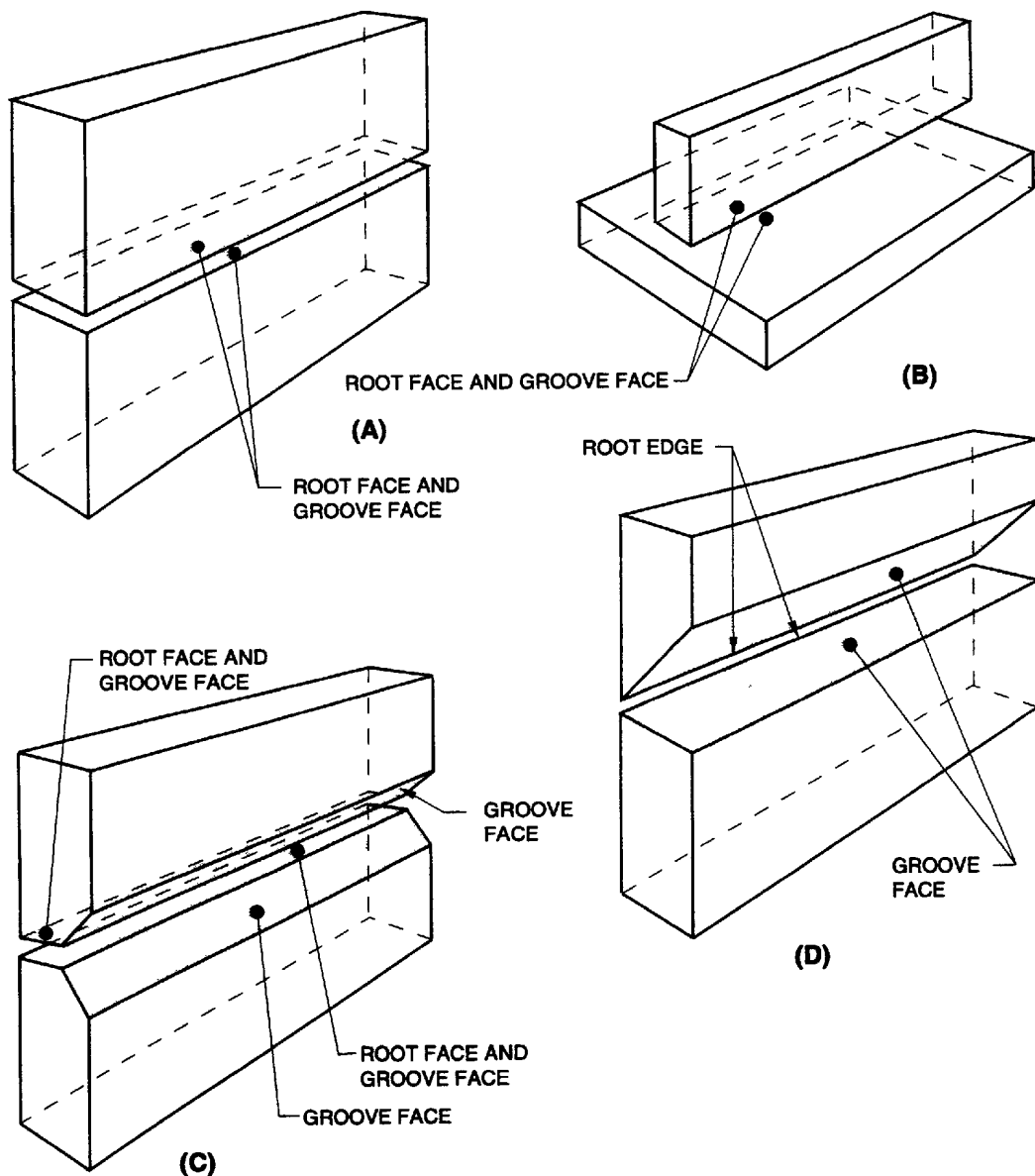


Figure 1.12 - Groove Face, Root Edge, and Root Face

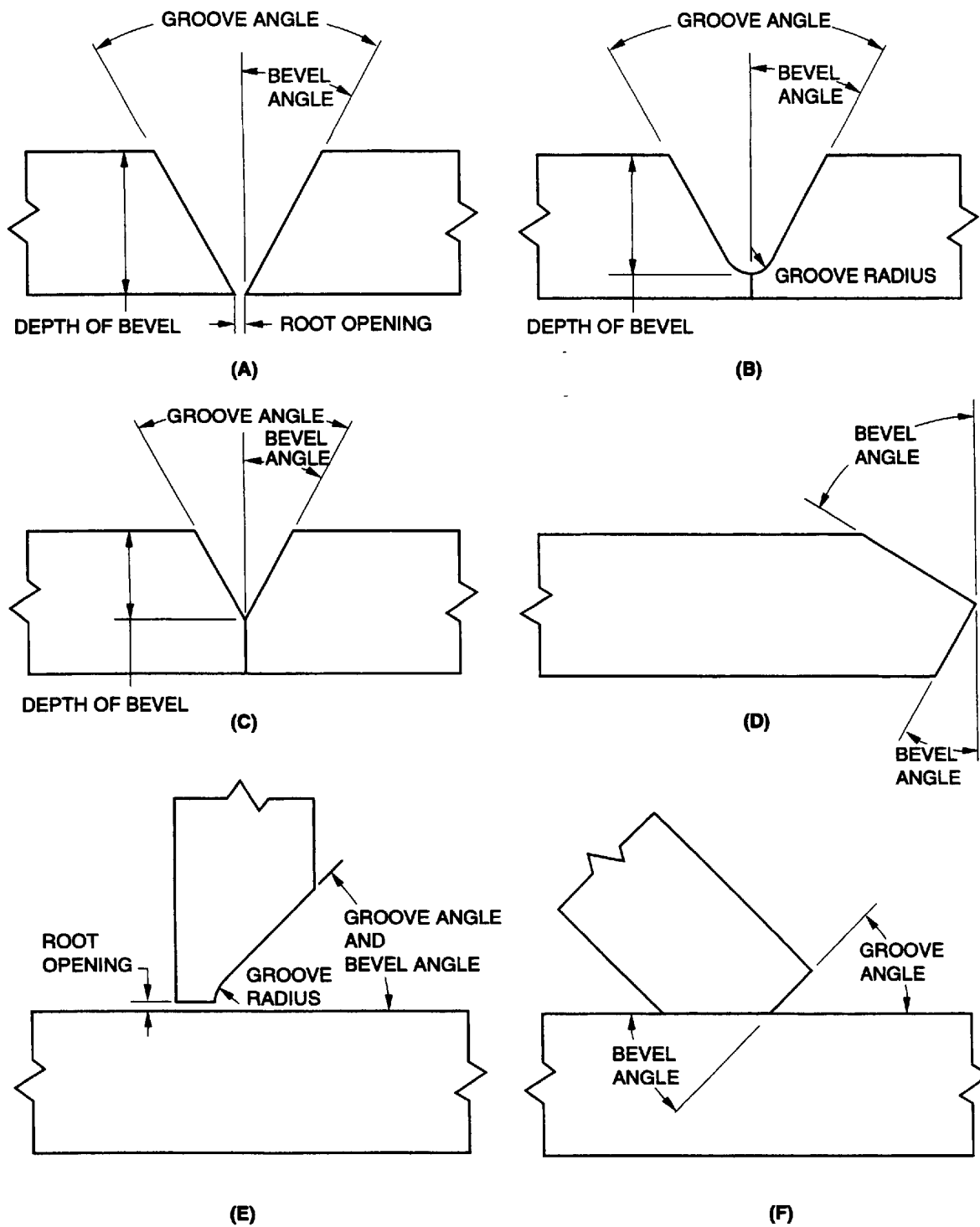


Figure 1.13 - Bevel Angle, Depth of Bevel, Groove Angle, Groove Radius and Root Opening

TERMS & DEFINITIONS

bevel - An angular edge shape.

bevel angle - The angle between the bevel of a joint member and a plane perpendicular to the surface of the member, Figure 1.13. This dimension equals one-half of the groove or included angle when the edges of both members are prepared at an angle. When only one member is prepared at an angle, this dimension is still indicated in the same position on the welding symbol for groove angle, but equals the total degree of preparation for the groove.

butt joint - A joint between two members aligned approximately in the same plane. See Figures 1.1 (A), 1.2 (A), 1.3, 1.4 and 1.6

butting member - A joint member that is prevented by the other member from movement in a direction perpendicular to its thickness dimension. For example, both members of a butt joint, or one member of a T-joint or corner joint. See Figure 1.4.

corner joint - A joint between two members located approximately at right angles to each other in the form of an L. See Figures 1.1 (B), 1.2 (B) and 1.7.

depth of bevel - the perpendicular distance from the base metal surface to the root edge or the beginning of the root face, Figure 1.13.

edge joint - A joint between the edges of two or more parallel or nearly parallel members. See Figures 1.1 (E), 1.2 (E) and 1.10.

edge preparation - The preparation of the edges of the joint members, by cutting, cleaning, plating, or other means.

edge shape - The shape of the edge of the joint member. See Figures 1.2 through 1.10.

flanged butt joint - A form of a butt joint in which at least one of the members has a flanged edge shape at the joint. See Figures 1.2(A) and 1.6.

flanged corner joint - A form of a corner joint in which the butting member has a flanged edge shape at the joint. See Figures 1.2 (B) and 1.7.

flanged edge joint - A form of an edge joint in which at least one of the members has a flanged edge shape at the joint. See Figure 1.7

flanged joint - A form of one of the five basic joint types in which at least one of the joint members has a flanged edge shape at the weld joint. See Figures 1.2 and 1.5 through 1.10.

flanged lap joint - A form of a lap joint in which at least one of the members has a flanged edge shape at the joint, and edge weld is not applicable. See Figures 1.2 and 1.9.

flanged T-joint - A form of a T-joint in which the butting member has a flanged edge shape at the joint, and an edge weld is not applicable. See Figures 1.2 and 1.8.

groove angle - The total included angle of the groove between workpieces, see Figure 1.13. In joints where both edges of the workpieces are prepared at an angle this dimension is the total of both (shown as a degree dimension, placed directly above the weld symbol on other side designations, and directly below the symbol on arrow side designations).

groove face - The surface of a joint member included in the groove. The angular distance between the surface of the base metal to the root edge, including any root face, Figure 1.12.

groove radius - The radius used to form the shape of a J or U groove weld. See Figure 1.13.

Joint - The junction of members or the edges of members that are to be joined or have been joined.

Joint design - The shape, dimensions and configuration of the joint.

Joint filler - A metal plate inserted between the splice member and thinner joint member to accommodate joint members of dissimilar thickness in a spliced butt joint. See Figure 1.3.

Joint geometry - The shape and dimensions of a joint in cross section prior to welding.

Joint root - That portion of a joint where the members approach closest to each other. When viewed in cross section the joint root may be either a point, a line, or an area. Illustrated in Figure 1.11.

Joint type - A weld joint classification based on five basic joint configurations such as a butt joint, corner joint, edge joint, lap joint and t-joint. See Figure 1.1.

lap joint - A joint between two overlapping members in parallel planes. See Figure 1.1 (D), 1.2 (D), 1.4 and 1.9.

nonbutting member - A joint member that is free to move in any direction perpendicular to its thickness dimension. For example, both members of a lap joint or one member of a T-joint or corner joint. See Figure 1.4.

root edge - is a root face of zero width, see Figure 1.12.

root face - that portion of the groove face within the joint root, Figure 1.12 (also know as nose, flat, or landing). Although not shown by dimension on the weld symbol, when the depth of preparation for groove welds is subtracted from the thickness of the workpiece, the difference is equals the root face of the joint.

root opening - a separation at the joint root between the workpieces. See Figure 1.13 (A & E).

spliced joint - A joint in which an additional workpiece spans the joint and is welded to each member. See Figure 1.3

splice member - The workpiece that spans the joint in a spliced joint. See Figure 1.3

surface preparation - The operations necessary to produce a desired or specified surface condition. For example the holes or slots cut into one member of a lap joint to accommodate a spot or slot weld.

T - joint - A joint between two members located approximately at right angles to each other in the form of a T. See Figures 1.1 (C), 1.2 (C), 1.4 and 1.8.

weld groove - the channel in the surface of a workpiece or an opening between two joint members that provides space to contain a weld.

Review 1:

WELDED JOINT TERMINOLOGY

For items 1-10 below circle T if true, or F if false for each statement given.

- T F 1. There are five basic joints used in welded metal fabrication.
- T F 2. Flanged and spliced joints are included in the five basic joint arrangements.
- T F 3. A nonbutting member is a joint member that is prevented by the other member, from movement in one direction perpendicular to its thickness dimension.
- T F 4. Flanged joints can be formed into any one of the five basic joint arrangements.
- T F 5. When a joint is viewed in cross section the edge preparations of the mating members often resemble the weld type required.
- T F 6. Two single-j-groove edge shapes placed approximately in the same plane form a u-groove.
- T F 7. Joint geometry is defined as the shape, dimensions, and configuration of a joint.
- T F 8. The shape and dimensions of a joint when viewed in cross section prior to welding is known as joint design.
- T F 9. The term groove radius applies to j- and u- groove welded joints.
- T F 10. Bevel angle is the total included angle of the groove between workpieces.

Match the terms given in Column 1 (11-24) with the statements provided in Column 2 (A-N). Indicate your choice by writing the letter from column 2 in the space provided next to the terms in column 1.

COLUMN 1

- _____ 11. butt joint
- _____ 12. depth of bevel
- _____ 13. edge joint
- _____ 14. groove angle
- _____ 15. bevel angle
- _____ 16. groove face
- _____ 17. corner joint
- _____ 18. bevel
- _____ 19. root edge
- _____ 20. groove radius
- _____ 21. joint root
- _____ 22. root face
- _____ 23. holes and slots
- _____ 24. splice member

COLUMN 2

- A. Term associated with the shape of a J- or U-groove.
- B. A joint between two members located at approximately right angles to each other.
- C. A root face of approximately zero width.
- D. The surface of a joint member included in the groove.
- E. A chamfered edge preparation.
- F. One half of the total included angle of a groove between workpieces with two angular edge shapes.
- G. That portion of the joint where the members approach closest to each other.
- H. The total included angle of the groove between workpieces.
- I. Sometimes referred to as the land, nose or flat.
- J. A joint between the edges of two or more parallel or nearly parallel members.
- K. Examples of surface preparations made to one or more members of a joint.
- L. The perpendicular distance from the base metal surface to the root edge or the beginning of the root face.
- M. A joint between two members aligned approximately in the same plane.
- N. An additional workpiece spanning the joint that is welded to each joint workpiece.

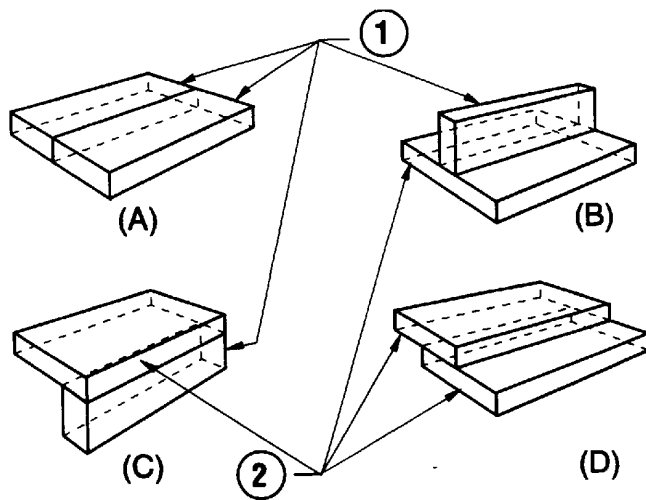


Figure 1

25. Identify the four types of joints shown in Figure 1 above:

(A) _____

(B) _____

(C) _____

(D) _____

26. #1 in Figure 1 identifies _____ members.

27. #2 in Figure 1 identifies _____ members.

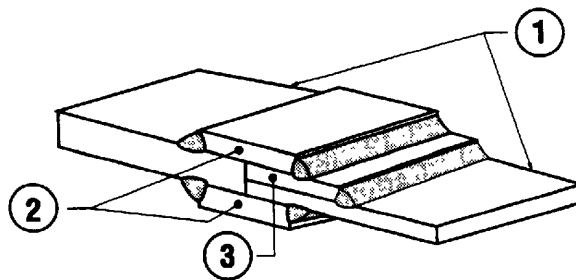
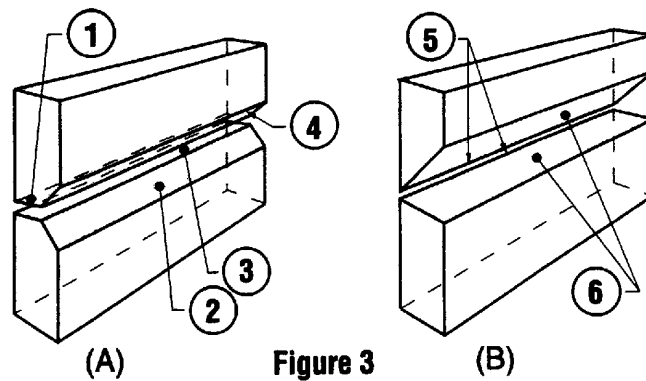


Figure 2

28. The type of joint shown in Figure 2 above represents a _____ joint

29. The workpieces shown in Figure 2 identify: (#1) _____

(#2) _____; and (#3) _____.



30. Identify the types of joints shown in Figure 3 above:

(A) _____

(B) _____

Note: Two answers may not apply to all questions in 31-38 below:

31. The portion of the joint labeled #1 in Figure 3 identifies _____ and _____.

32. The portion of the joint labeled #2 in Figure 3 identifies _____ and _____.

33. The portion of the joint labeled #3 in Figure 3 identifies _____ and _____.

34. The portion of the joint labeled #4 in Figure 3 identifies _____ and _____.

35. The portion of the joint labeled #5 in Figure 3 identifies _____ and _____.

36. The portion of the joint labeled #6 in Figure 3 identifies _____ and _____.

37. At the joint, the edge shapes used in Figure 3(A) are _____ and _____.

38. At the joint, the edge shapes used in Figure 3(B) are _____ and _____.

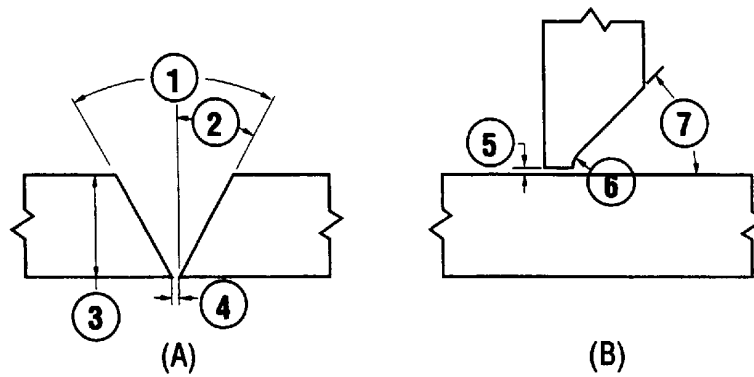


Figure 4

39. Identify the types of joints shown in Figure 4 above:

(A) _____

(B) _____

Note: Two answers may not apply to all questions in 40-48 below:

40. The portion of the joint labeled #1 in Figure 4 identifies _____ and _____.

41. The portion of the joint labeled #2 in Figure 4 identifies _____ and _____.

42. The portion of the joint labeled #3 in Figure 4 identifies _____ and _____.

43. The portion of the joint labeled #4 in Figure 4 identifies _____ and _____.

44. The portion of the joint labeled #5 in Figure 4 identifies _____ and _____.

45. The portion of the joint labeled #6 in Figure 4 identifies _____ and _____.

46. The portion of the joint labeled #7 in Figure 4 identifies _____ and _____.

47. At the joint, the edge shapes used in Figure 4(A) are _____ and _____.

48. At the joint, the edge shapes used in Figure 4(B) are _____ and _____.

Learning Activity 2:

WELD TERMINOLOGY

Types of Welds

As was shown in Figure 1.1 from the previous learning activity, numerous welds can be applied to the various types of joints. Using ANSI/AWS A2.4, *Standard Symbols for Welding, Brazing and Nondestructive Examination* as a guideline, there are nine categories of welds associated with weld symbols. In each of these categories certain weld types apply. The categories are:

- 1) Groove Welds
- 2) Fillet Welds
- 3) Plug or Slot Welds
- 4) Stud Welds
- 5) Spot or Projection Welds
- 6) Seam Welds
- 7) Back or Backing Welds
- 8) Surfacing Welds
- 9) Flange Welds

With the variety of joint geometries and weld types available, the welding fabricator can choose the one which best suits his needs. This choice could be based on considerations such as:

- accessibility to the joint for welding
- type of welding process being used
- suitability to the structural design
- cost of welding

Groove Welds

A *groove weld* is, "a weld made in a groove between the workpieces." There are eight types of groove welds:

- 1) square-groove
- 2) scarf

- 3) v-groove
- 4) bevel-groove
- 5) u-groove
- 6) j-groove
- 7) flare-v-groove
- 8) flare-bevel-groove

Their names imply what the actual configurations look like when viewed in cross section. All of these groove weld types can be applied to joints which are welded from a single side or both sides. Figure 2.1 illustrates typical configurations for single- and double- groove welded joints. As would be expected, a single-welded joint is "a fusion welded joint that is welded from one side only." Similarly, a double-welded joint is "a fusion welded joint that is welded from both sides."

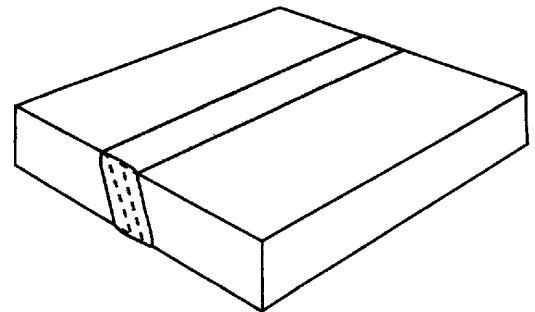
Groove welds of different types are used in many combinations. Selection is influenced by accessibility, economy, adaptation to structural design, expected distortion and the type of welding process used.

Square-groove welds are the most economical to use, but are limited by the thickness of the joint. Complete penetration square groove welds, welded from one side, are generally not used for material thicker than one quarter inch.

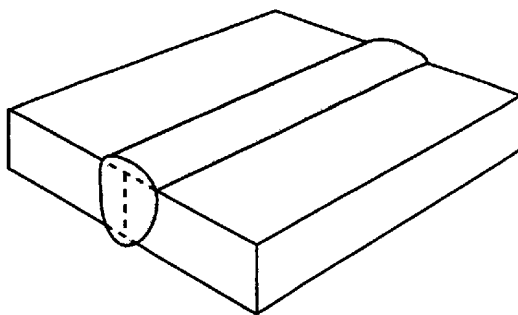
Thicker material requires the selection of joint geometries that accommodate other types of groove welds. On thicker joints the particular geometry must provide accessibility for welding and ensure weld soundness and strength. For economical reasons these joint designs should be selected with root openings and groove angles that require the least amount of weld metal, but still meet the service conditions of the weldment.

Selection of root openings and groove angles is influenced by the metal to be joined, location of the joint within the weldment, and required service conditions.

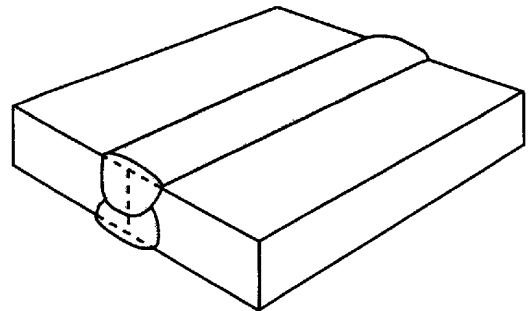
Welds in j- and u-grooves can be used to minimize weld metal requirements when economic factors outweigh the cost of edge preparation. These types of welds are particularly useful in thicker sections. Single-bevel and j-groove welds are more difficult to weld than v- or u-groove welds because of the one vertical edge. Flare v-groove and flare-bevel groove welds are used in connection with flanged or round members.



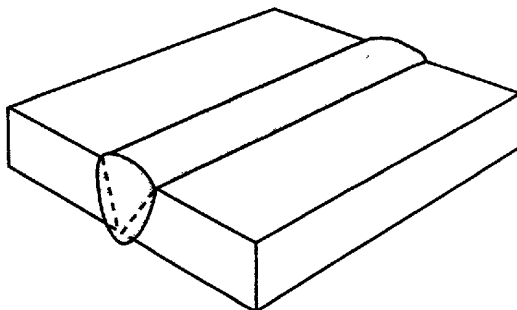
(A) Single Scarf-Groove (used for brazing)



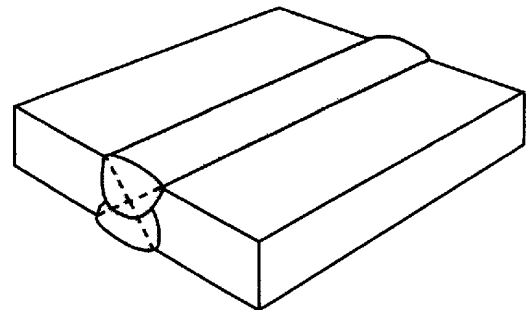
(B1) Single-Square-Groove Weld



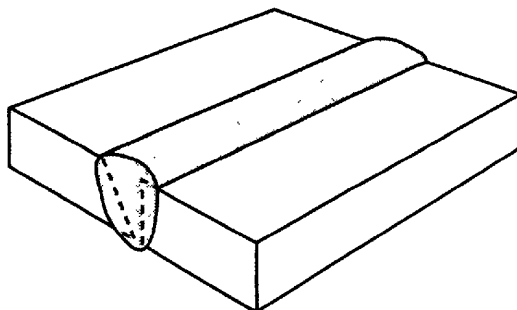
(B2) Double-Square-Groove Weld



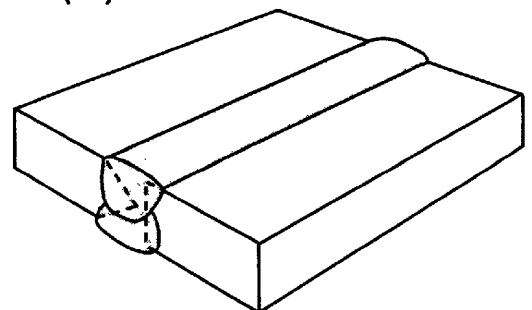
(C1) Single-V-Groove Weld



(C2) Double V-Groove Weld

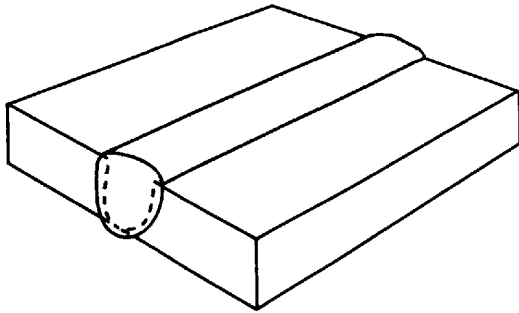


(D1) Single-Bevel-Groove Weld

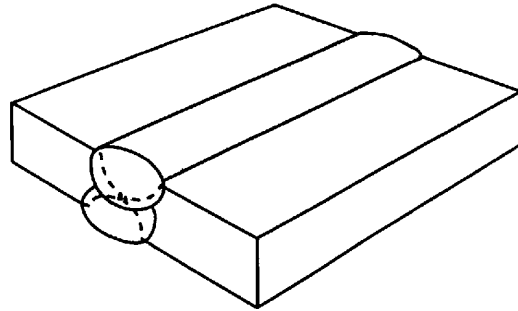


(D2) Double-Bevel-Groove Weld

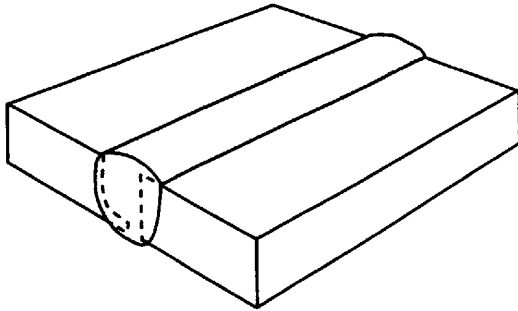
Figure 2.1 - Single and Double Groove Welds



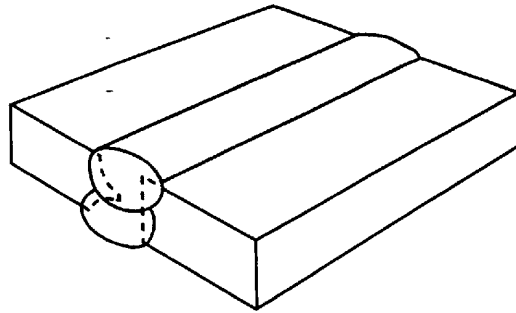
(E1) Single-U-Groove Weld



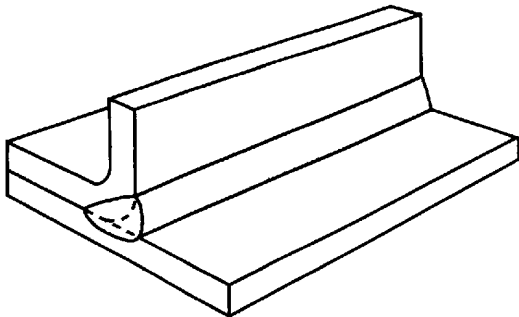
(E2) Double-U-Groove Weld



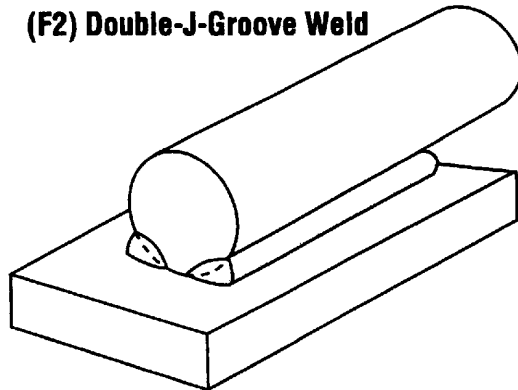
(F1) Single-J-Groove Weld



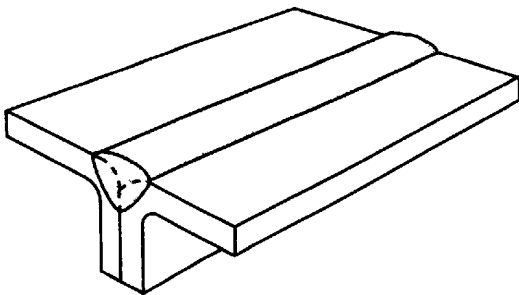
(F2) Double-J-Groove Weld



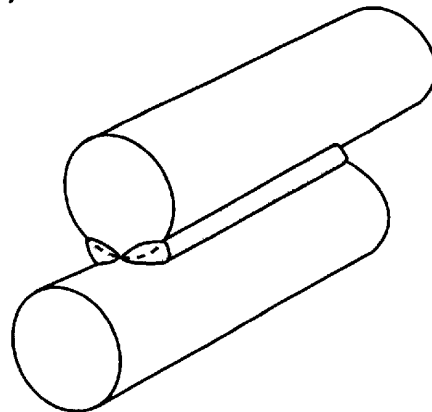
(G1) Single-Flare-Bevel-Groove Weld



(G2) Double-Flare-Bevel-Groove Weld



(H1) Single-Flare-V-Groove Weld



(H2) Double-Flare-V-Groove Weld

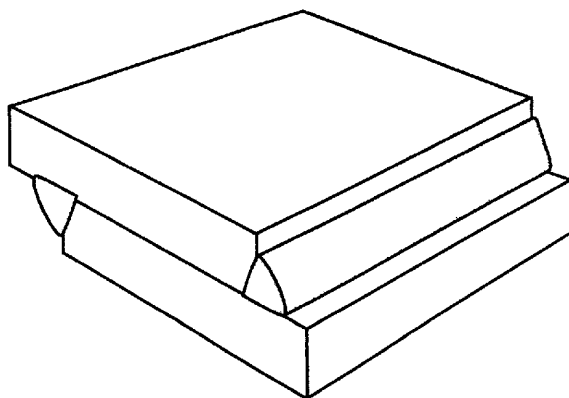
Figure 2.1 - Single and Double Groove Welds (continued)

Fillet Welds

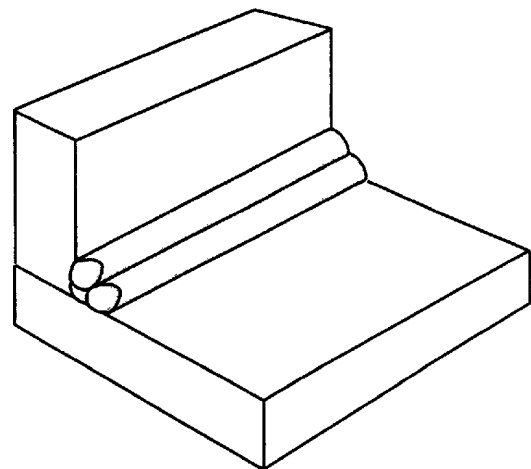
ANSI/AWS A2.4 defines a *fillet weld* as “a weld of approximately triangular cross section joining two surfaces approximately at right angles to each other in a lap joint, t-joint, or corner joint.” When the design permits, fillet welds are used in preference to groove welds for economic reasons. Edge preparations are not required for fillet welding, but surface cleaning may be needed. Unlike groove welds, a fillet weld does not take its name from an associated joint geometry. It is a particular type of weld applied to a lap, t- or corner joint. Fillet welds are sometimes used in combination with groove welds. Figure 2.2 shows typical fillet welds applied to corner, t, and lap joints.

Fillet welds are made using both single and double sided welds. They are also applied using a single weld pass or multiple weld passes.

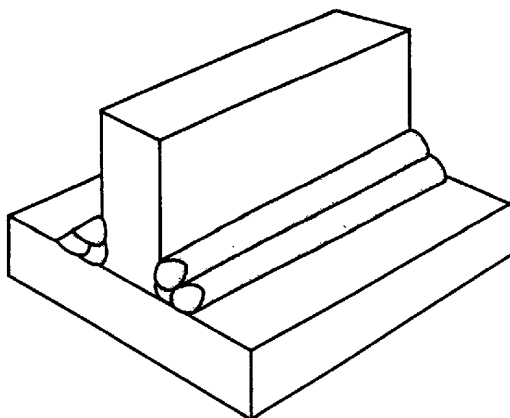
Besides continuous pass welds (the length of the joint), fillet welds are often intermittently staggered or chained. A *staggered intermittent fillet weld* is, “an intermittent weld on both sides of a joint in which the weld increments on one side are alternated with those on the other.” A *chain intermittent fillet weld* is, “an intermittent weld on both sides of a joint in which the weld increments on one side are approximately opposite those on the other side.” Figure 2.2 (E & F) illustrates both types of intermittent fillet welds.



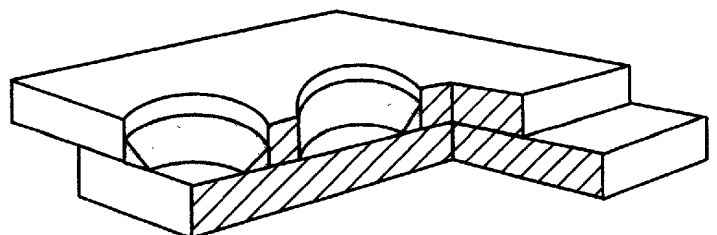
(A) Double Sided - Single Pass Fillet Welds on a Lap Joint



(B) Single Sided - Multiple Pass Fillet Welds on a Corner Joint

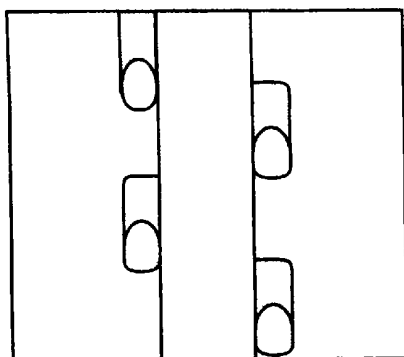


(C) Double Sided - Multiple Pass Fillet Welds on a T Joint

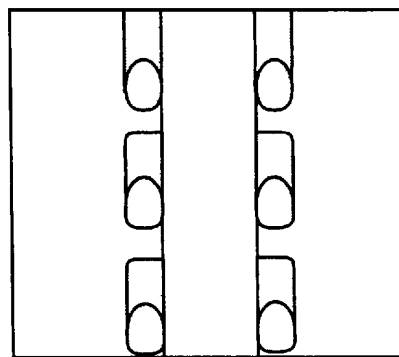


(D) Fillet Welds around the diameter of a hole

Figure 2.2 - Fillet Weld Applications



**(E) Staggered Intermittent Fillet Welds
Top View**



**(F) Chain Intermittent Fillet Welds
Top View**

Figure 2.2 - Fillet Weld Applications (continued)

Plug and Slot Welds

Two types of welds used in joining overlapping members are plug and slot welds. The *plug weld* is "a weld made in a circular hole in one member of a joint fusing that member to another member." A *slot weld* is "a weld made in an elongated hole in one member of a joint fusing that member to another member. The hole may be open at one end." Plug and slot welds require definite depths of filling. Figure 2.3 (A&B) shows illustrations of plug and slot welds. A fillet weld applied in a circular hole, (Figure 2.2, D), or slot is not considered a plug or slot weld.

Stud Welds

In the 1989 edition of ANSI/AWS A2.4 a symbol for this type of weld was added. A *stud weld* is, "a general term for joining a metal stud or similar part to a workpiece. Welding may be accomplished by arc, resistance, friction, or other process with or without external gas shielding. Figure 2.3 (C) provides an example of a stud weld.

The most common stud materials welded with the arc stud welding process are low carbon steel, stainless steel, and aluminum. Other materials are used for studs on a special application basis.

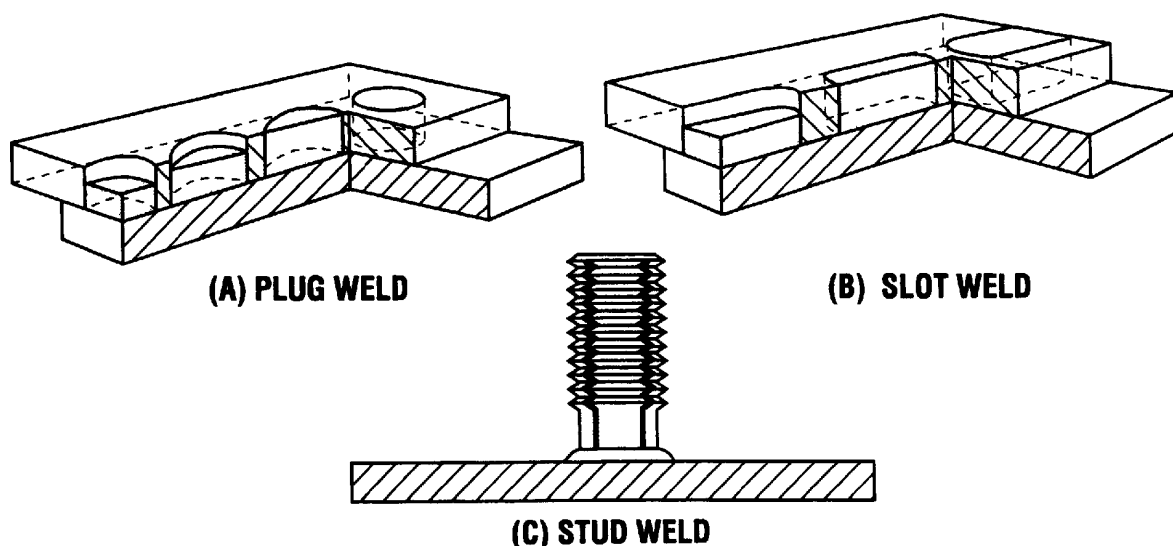


Figure 2.3 - Plug, Slot, and Stud Welds

The bases most stud welds are round. However, there are many applications which use a square or rectangular shaped stud. Applications include attaching wood floors to steel decks or framework; fastening lining or insulation in tanks, boxcars, and other containers; mounting machine accessories; securing tubing and wire harnesses; and welding shear connectors and concrete anchors to structures.

Spot and Projection Welds

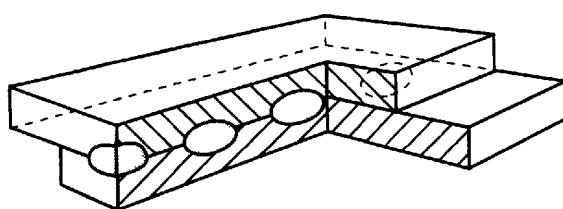
A *spot weld* is, "a weld made between and upon overlapping members in which coalescence (the act of combining or uniting) may start and occur on the *faying surfaces* or may begin from the outer surface of one member." Faying surface is defined as, "the mating surface of a member that is in contact with or in close proximity to another member to which it is to be joined." Spot welds are commonly associated with resistance welding. However, a very effective way to join a lap joint shape on thin metals is with an arc spot weld. In arc spot welding, the weld forms by melting through the top member using an arc welding process, and fusion occurs between it and the

overlapping member." Figure 2.4 (A & B) illustrates resistance and arc spot welds.

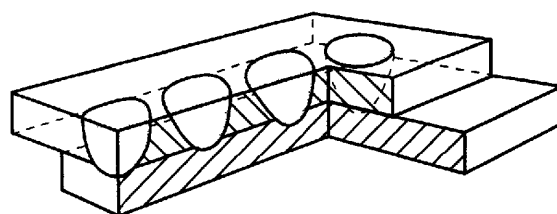
Projection welds are made using the resistance welding process. The weld is formed by the heat obtained from the resistance to the flow of the welding current. The resulting welds are localized at predetermined points by projections, embossments, or intersections. Figure 2.4 (C) shows a cross-sectional view of an embossed member of a lap joint to be projection welded and the desired weld upon completion.

Seam Welds

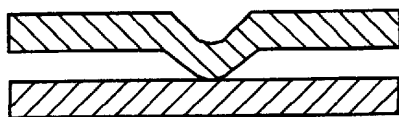
A *seam weld* is "a continuous weld made between or upon overlapping members, in which coalescence may start and occur on the faying surfaces, or may have proceeded from the outer surface of one member. The continuous weld may consist of a single weld bead or a series of overlapping spot welds. Some means must be provided to move the welding head along the seam during welding. This type of weld is associated with arc and resistance welding. Seam welds for both processes are illustrated in Figure 2.5 (A,B,C & D).



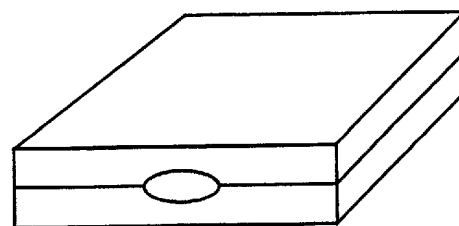
(A) RESISTANCE SPOT WELD



(B) ARC SPOT WELD



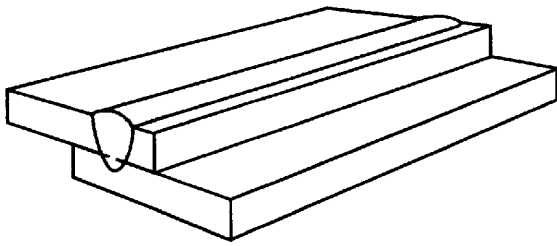
Embossed Top Member



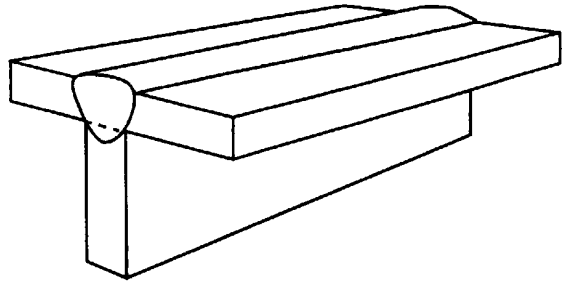
Desired Weld

(C) PROJECTION WELD

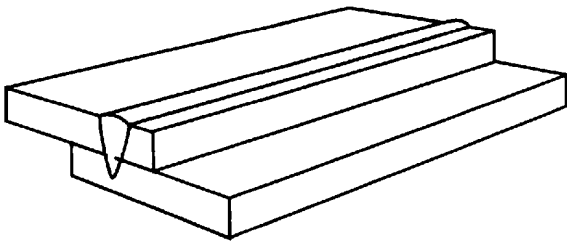
Figure 2.4 - Spot and Projection Welds



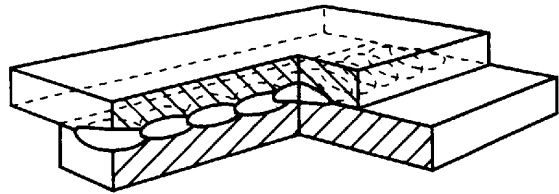
(A) ARC SEAM WELD



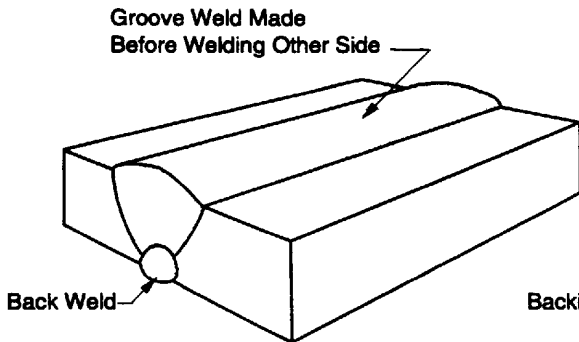
(B) ARC SEAM WELD



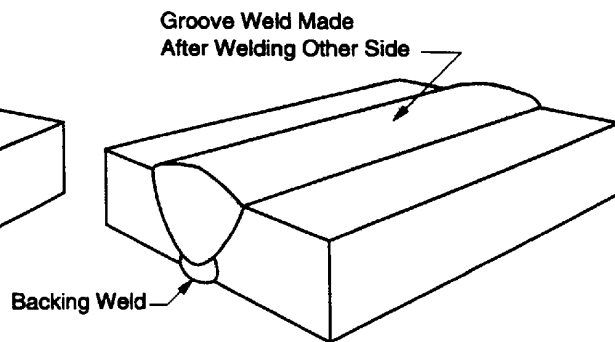
(C) ELECTRON BEAM SEAM WELD



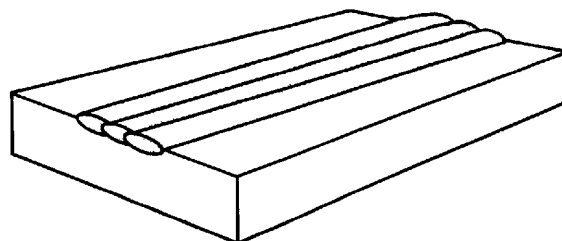
(D) RESISTANCE SEAM WELD



(E) BACK WELD



(F) BACKING WELD



(G) SURFACING WELD

Figure 2.5 - Seam, Back, Backing and Surfacing Welds

Back and Backing Welds

As their names imply, these welds are made on the back side of a weld joint. Although they apply to the same location, they are deposited differently. AWS A3.0 describes a *back weld* as “a weld made at the back of a single groove weld.” A *backing weld* is “backing in the form of a weld.” A back weld is applied after the front side is welded, while the backing weld is deposited before welding the front side. Figure 2.5 (E & F) on the previous page, illustrates the application of both back and backing welds.

Surfacing Welds

This type of weld is applied to the surface of a metal. A *surfacing weld* is defined as, “a weld applied to a surface, as opposed to making a joint, to obtain desired properties or dimensions.” Figure 2.5 (G) illustrates a typical surfacing weld. Other terms associated with surfacing are:

Buildup, “a surfacing variation in which surfacing material is deposited to achieve the required dimensions”

Buttering, “a surfacing variation that deposits surfacing metal on one or more surfaces to provide metallurgically compatible weld metal for the subsequent completion of a weld”

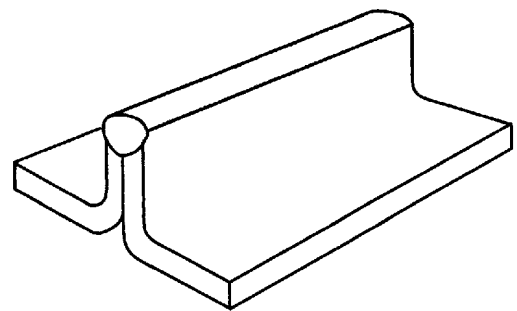
Cladding, “a surfacing variation that deposits or applies surfacing material usually to improve corrosion or heat resistance”

Hardfacing, “a surfacing variation in which surfacing material is deposited to reduce wear.”

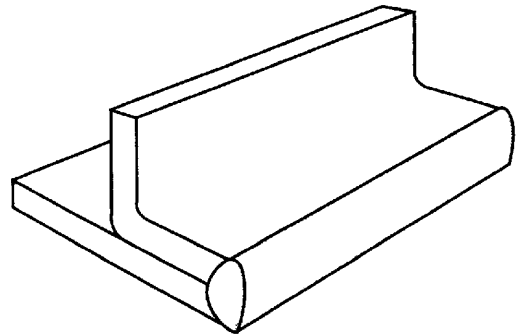
Flange Welds

Flange weld, in the case of symbol representation, refers to “a weld made on the edges of two or more joined members, usually light gage metal, with at least one flanged member.” Therefore, the symbol represents the use of a flanged member or members and not the specific weld type required.

An *edge weld* is, “a weld in an edge joint, a *flanged butt joint* or a *flanged corner joint* in which the full thickness of the members are fused.” An edge-flange weld has two flanged members, while a corner-flange weld has only



(A) Edge Weld in a Flange Butt Joint



(B) Edge Weld in a Flange Corner Joint

Figure 2.6 - Flange Weld Types

one of the members flanged. Figure 2.6 illustrates edge weld placements on corner and edge flange joints.

Completed Welds

Welding and fabrication personnel should be aware of terms associated with certain conditions or features of completed welds. Knowledge of these terms aids in the communication process, enhances one's ability to interpret welding symbol information and locate areas of a weld that may require additional post-weld cleaning or detailing.

Terms related to groove welds, Figure 2.7, consist of:

- Weld Face
- Weld Toe
- Weld Root
- Root Surface
- Face Reinforcement
- Root Reinforcement

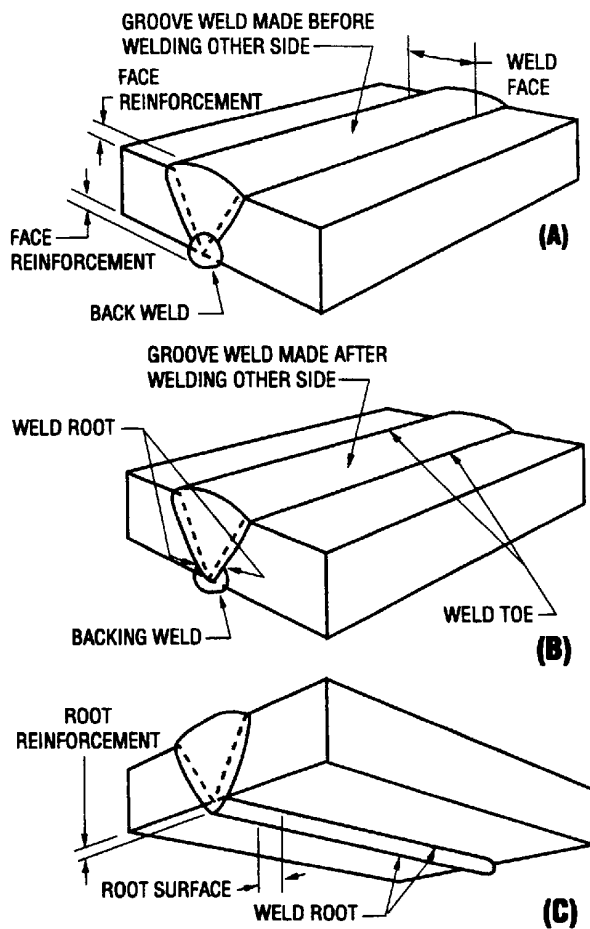


Figure 2.7 - Completed Groove Welds

Weld face is, “the exposed surface of a weld on the side from which welding was done.” *Weld toe* is, “the junction of the weld face and the base metal.” Opposite the weld face is the weld root. *Weld Root* is, “the points, shown in cross section, at which the root surface intersects the base metal surfaces.” Similar to weld face, is the *root surface*, or “the exposed surface of a weld opposite the side from which welding was done.” In other words the root surface is bounded by the weld root on either side.

Additional terminology associated with a groove weld relates to weld reinforcement. *Weld reinforcement* is, “weld metal in excess of the quantity required to fill a joint.” The *face reinforcement* (also known as the *crown*), refers to “weld reinforcement on the side of the joint from which welding was done.” Conversely, the *root*

reinforcement is, “weld reinforcement opposite the side from which welding was done.” Root reinforcement is used only in the case of a single welded joint, meaning welding performed from one side. When a double sided weld is made, the term face reinforcement is applied to the amount of reinforcement present on both sides. This point is illustrated in Figure 2.7(A) where a back weld is used.

Standard terminology also exists for parts of fillet welds. As with the groove weld, the surface of the fillet weld is referred to as the *weld face*. The junctions of the weld face with the base metal are the *weld toes*. The furthest penetration of the weld metal into the joint is the *weld root*. “The distance from the joint root to the toe of the fillet weld,” is called the *fillet weld leg*. Figure 2.8 identifies various parts of a fillet weld.

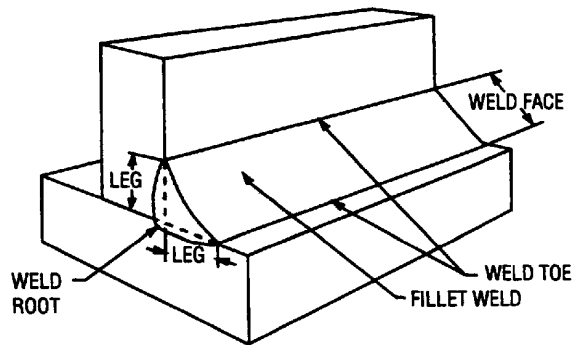


Figure 2.8 - Completed Fillet Weld

One other feature of a fillet weld (shown in Figure 2.13) is the weld throat. In general, this is the shortest distance through the cross section of the weld. Various types of fillet weld throats will be discussed in more detail under weld size terminology.

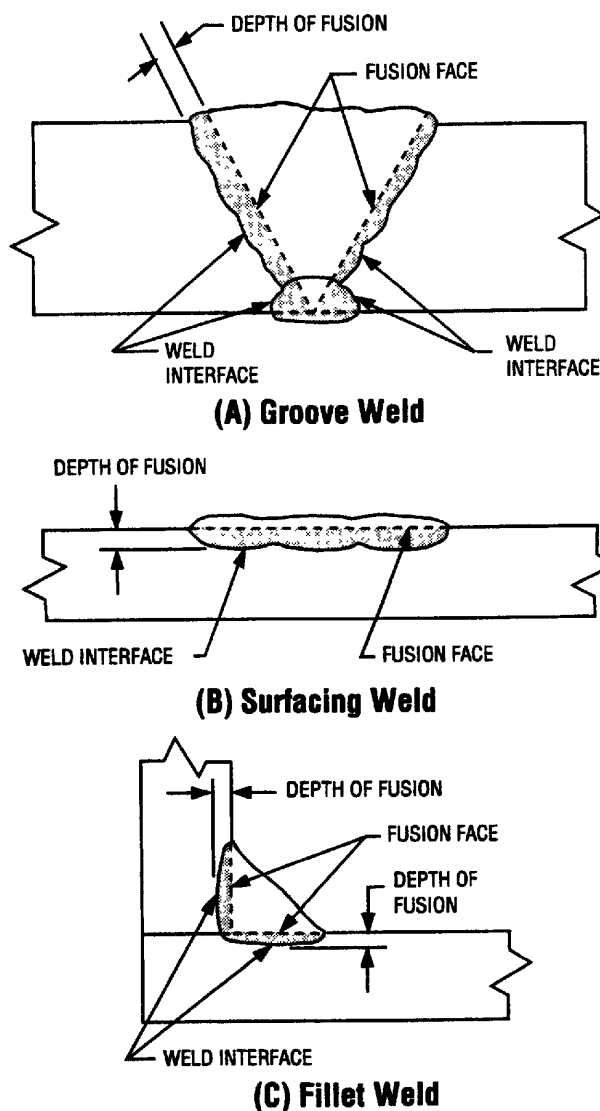
Fusion and Penetration Terminology

In general, fusion refers to the actual melting together of the filler metal and base metal, or of the base metal only. Penetration is a term which relates to the distance that the weld metal has progressed into the joint. The degree of

penetration achieved has a direct effect on the strength of the joint and is therefore related to the weld size.

Numerous terms exist which describe the degree or location of either fusion or penetration. During the welding operation, the original groove face is melted so that the final limit of the weld metal is deeper than the original surface. The groove face (before welding), is now referred to as the *fusion face* since it will be melted during welding. The boundary between the weld metal and base metal is referred to as the *weld interface*. The *depth of fusion* is, "the distance

from the fusion face to the weld interface." The depth of fusion is always measured perpendicular to the fusion face. "The area of base metal melted as determined on the cross section of a weld" is known as the *fusion zone*. These terms are applied similarly for other types of welds such as fillet and surfacing welds. Figure 2.9 illustrates various terms associated with fusion.



Note: Fusion zones indicated by shading.

Figure 2.9 - Fusion Terminology

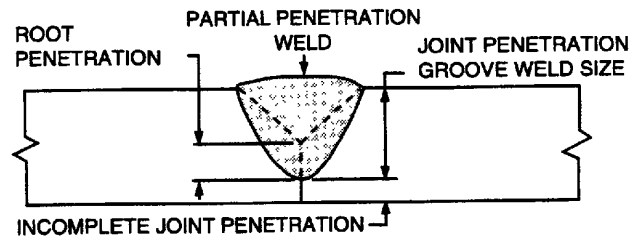


Figure 2.10 - Penetration

As shown in Figure 2.10, there are also several terms which refer to penetration of the weld. *Root penetration* is, "the distance that the weld metal has melted into the joint beyond the joint root." The *joint penetration* is, "the distance from the furthest extension of the weld into the joint to the weld face, excluding any weld reinforcement which may be present." For groove welds, this same distance is also referred to as the weld size. *Incomplete joint penetration* (commonly referred to as partial joint penetration) is "a joint root condition in a groove weld in which weld metal does not extend through the joint thickness."

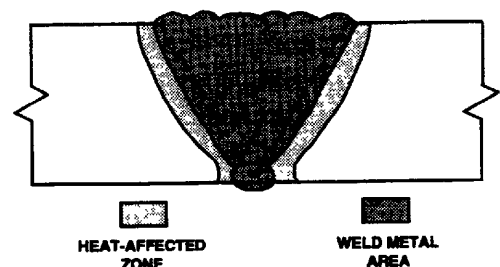


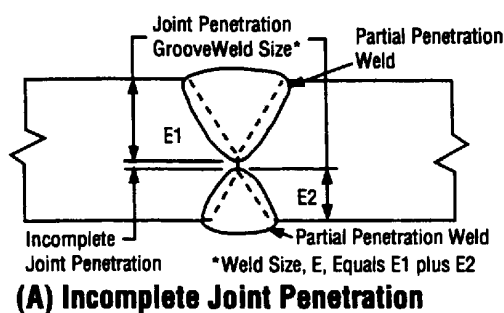
Figure 2.11 - Heat-Affected Zone

Another related term is *heat-affected zone*, Figure 2.11. This region is defined as "that portion of the base metal that has not been melted, but whose mechanical properties or microstructure have been altered by the heat of welding, brazing, soldering, or cutting."

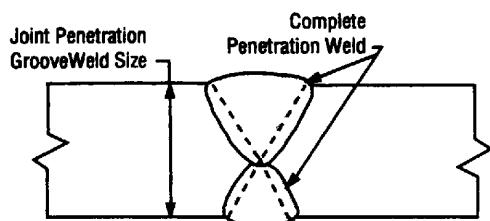
Weld Size Terminology

The previous topic describes joint penetration, and the relationship to weld size, for single-groove weld configurations. For a double-groove weld configuration where the joint penetration is less than complete, the weld size is equal to the sum of the joint penetrations from both sides. Refer to Figure 2.12 (A)

In a complete penetration groove weld, the weld size is equal to the thickness of the thinner of the two members joined, since there is no credit given for any weld reinforcement that is present. Refer to Figure 2.12 (B).



(A) Incomplete Joint Penetration

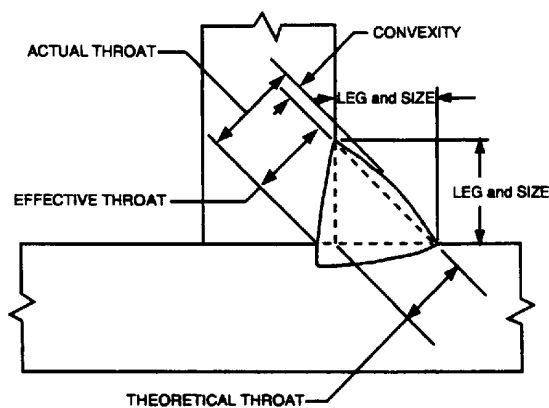


(B) Complete Joint Penetration

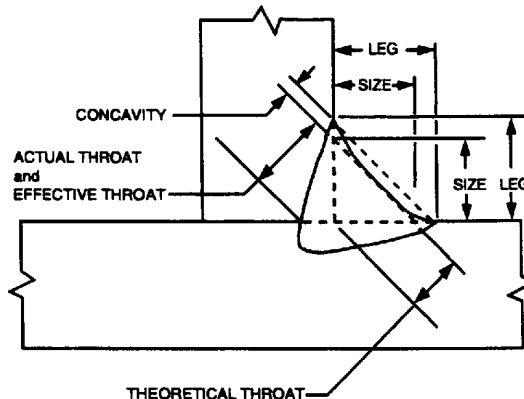
Figure 2.12 - Penetration and Weld Size

To determine the size of a fillet weld, you must first know whether the final weld configuration is *convex* or *concave*. Convex means that the weld face exhibits some buildup causing it to appear curved slightly outward. This is referred to as the amount of convexity. *Convexity* in a fillet weld is synonymous with weld reinforcement in a groove weld. If a weld has a concave profile, this means that its face is "dished in."

For either configuration, the fillet weld size for *equal leg fillet welds* is described as, "the leg lengths of the largest isosceles (two legs of equal



CONVEX FILLET WELD



CONCAVE FILLET WELD

Figure 2.13 - Fillet Weld Size

length) right triangle which can be inscribed within the fillet weld cross section."

These inscribed isosceles right triangles are shown with dotted lines in the two illustrations for Figure 2.13. So, for the convex fillet weld, the leg and size are equal. However, the size of a concave fillet weld is slightly less than its leg length.

For *unequal leg fillet welds*, the fillet weld size is defined as, "the leg lengths of the largest right triangle that can be inscribed within the fillet weld cross section."

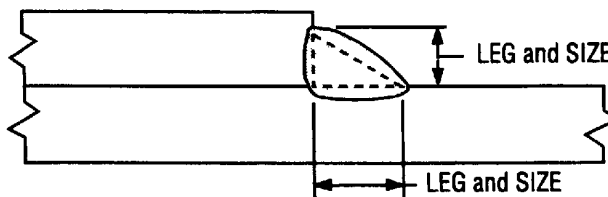


Figure 2.14 - Unequal Leg Fillet Weld

It can be noted that there are additional notations on the illustrations in Figure 2.13 which refer to fillet weld throats. There are really three different types of *weld throats*. The first is the theoretical throat, or “the minimum amount of weld which the designer counts on when he originally specifies a weld size.”

The *theoretical throat* is described as, “the distance from the beginning of the joint root perpendicular to the hypotenuse (side of the triangle opposite the right angle) of the largest right triangle that can be inscribed within the cross section of a fillet weld. This dimension is based on the assumption that the root opening is equal to zero.”

Effective throat takes into account any additional joint penetration that may be present. So, the effective throat can be defined as, “the minimum distance minus any convexity between the weld root and the face of a fillet weld.” The final throat dimension, the actual throat, takes into account both the joint penetration as well as any additional convexity present at the weld face.

Actual throat is, “the shortest distance between the weld root and the face of a fillet weld.” For a concave fillet weld, the effective throat and actual throat are equal, since there is no convexity present.

Welding personnel may also be asked to somehow determine the sizes of other types of welds. One example might be a spot or seam weld, where the weld size is equal to the width of the weld metal in the plane of the faying surfaces.

For an edge weld on a flanged joint, the weld size is equal to the total thickness of the weld from the weld root to the weld face.

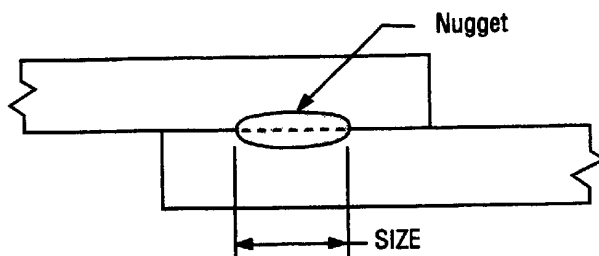


Figure 2.15 - Size of Seam or Spot Weld

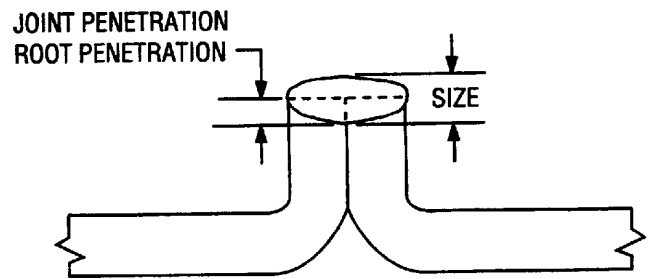
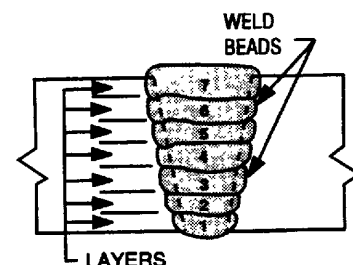
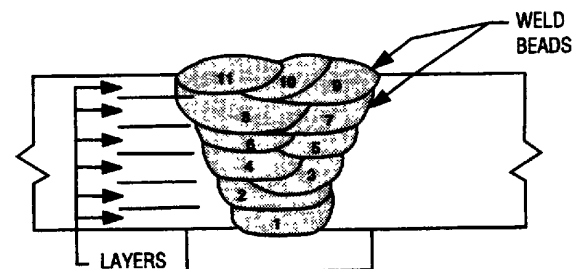


Figure 2.16 Edge Weld Size

Weld Application Terminology

To complete this discussion of weld terms, it seems appropriate to mention some of the terminology associated with the actual application of welds. Often welding procedures will refer to these details, so welding personnel should be familiar with their meanings. The first aspect is the difference among the terms weld pass, weld bead and weld layer. A *weld pass* is a single progression of welding along a joint. The *weld bead* is that weld which results from a weld pass. A *weld layer* is a single level of weld within a multiple-pass weld. A weld layer may consist of a single bead or multiple beads.



CROSS-SECTIONAL WELDING SEQUENCE

Figure 2.17 - Weld pass, bead and layer.

When a weld bead is deposited, it could have a different name, depending upon the technique the welder uses. If the welder progresses along the joint with little or no side-to-side motion (oscillation), the resulting weld bead is referred to as a *stringer bead*. A *weave bead* results when the welder manipulates the electrode laterally, or side to side, as the weld is deposited along the joint.

The weave bead is typically wider than the stringer bead. Due to the amount of lateral motion used, the travel speed, as measured along the longitudinal axis of the weld, is less than would be the case for a stringer bead.

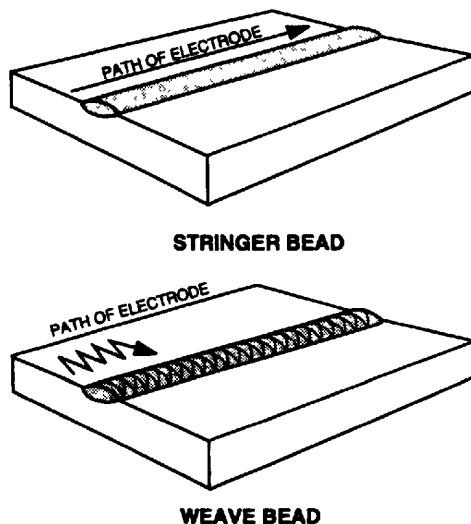
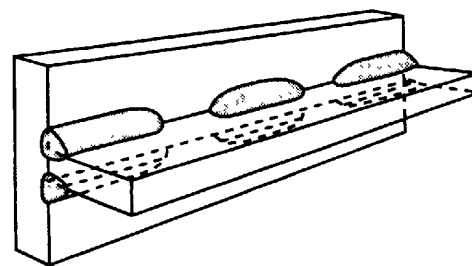


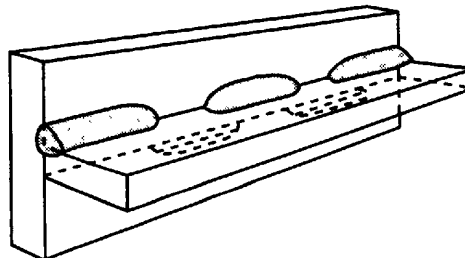
Figure 2.18 - Weld Applications

When fillet welds are required, there will be some cases where the design does not warrant the use of continuous welds. The designer may therefore specify intermittent fillet welds. If there are intermittent fillet welds specified on both sides of a particular joint, they can be detailed as either chain intermittent or staggered intermittent fillet welds. The *chain intermittent fillet weld* has the increments on either side of the joint directly opposite each other.

Similarly, a *staggered intermittent fillet weld* is an intermittent fillet weld on both sides of a joint in which the weld increments on one side are alternated with respect to those on the other side.



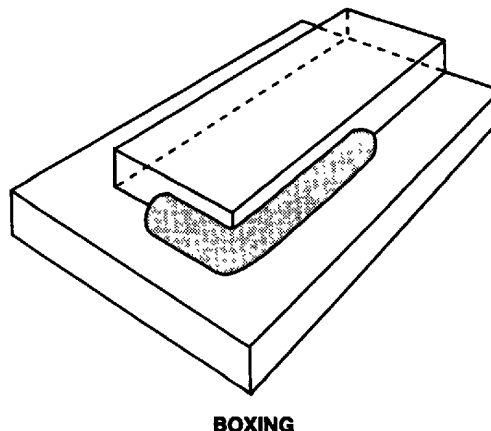
CHAIN INTERMITTENT FILLET WELD



STAGGERED INTERMITTENT FILLET WELD

Figure 2.19 - Welding Sequence

Another term related to the actual welding operation is *boxing* (commonly referred to as an end return). *Boxing* is defined as, "the continuation of a fillet weld around a corner of a member as an extension of the principal weld."



BOXING

Figure 2.20 - Welding Sequence

Finally, there are several terms which describe the actual sequence in which the welding is to be done. This is commonly done to reduce the amount of distortion caused by welding. Three common techniques are: *backstep sequence*, *block sequence* and *cascade*

sequence. The backstep sequence is a technique where each individual weld pass is deposited in the direction opposite that of the overall progression of welding.

A *block sequence* is defined as “a combined longitudinal and cross sectional sequence for a continuous multiple pass weld in which separated increments are completely or partially welded before intervening increments are welded.” With the block sequence, it is important that each subsequent layer is slightly shorter than the

previous one so that the end of the block has a gentle slope. This will provide the best chance of obtaining adequate fusion when the adjacent block is filled in later.

A *cascade sequence* is described as “a combined longitudinal and cross sectional sequence in which weld passes are made in overlapping layers.” This method differs from the block sequence in that each subsequent pass is longer than the previous one.

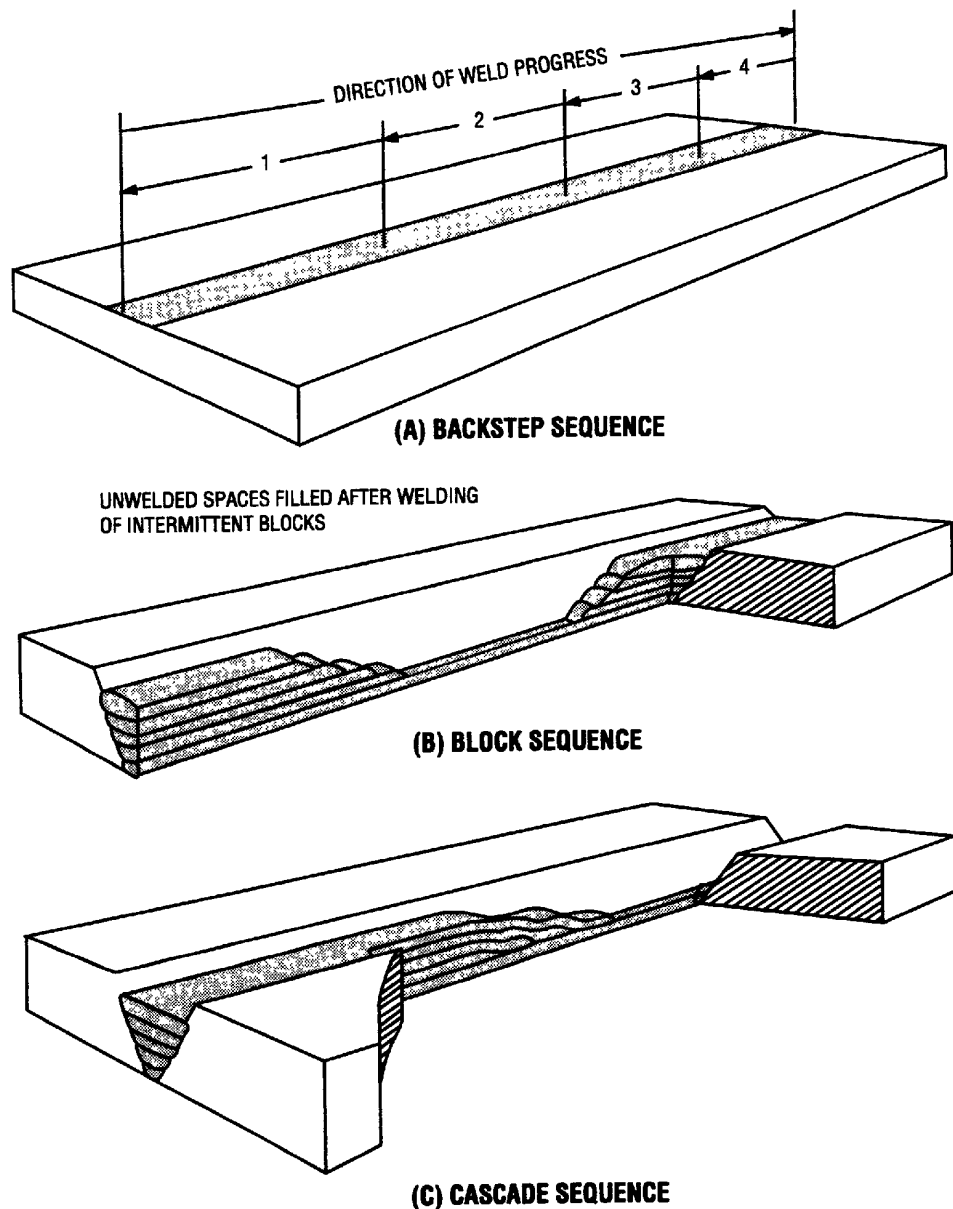


Figure 2.21 - Welding Sequence