

Materials & Tests Unit



NCDOT
(Steel Section)

FIELD

WELDING

PROCEDURES

4th Edition-June 2011
(contractor)

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Introduction

The information contained within this book of Approved Welding Procedures is intended to assist the NCDOT Construction Inspector and guide the Welding Contractor with acceptable procedures and practices for the application of weld in a field environment on NCDOT bridge projects. Additional information and procedures have been included to assist Bridge Maintenance Personnel with "Repair of Existing Structures". The information is in no way considered to be complete or all encompassing but instead offers aid to some of the most common applications to field welding that are found on NCDOT bridge construction projects. A Welding Procedure Specification (WPS) may be generated by an authorized person (i. e. CWI) and then submitted to the NCDOT Materials & Tests Unit (Steel Section) at 770A Park Centre Drive in Kernersville, NC 27284 (phone: 336-993-2300) for approval in the event that the contractor does not want to utilize the material provided.

These approved welding procedures may also be found at the following web address:

http://www.ncdot.org/doh/operations/materials/structural/appr_proc.html

This manual may also be found at the following web address:

<http://www.ncdot.org/doh/operations/materials/pdf/fwp.pdf>

Previous editions of this manual include:

1st Edition-October 2008

2nd Edition-April 2009

3rd Edition-May 2010

General Information

Reference Standards

As stated by the NCDOT “Standard Specifications For Roads and Bridges JULY 2006” page 4-55 section 440-7:

“Perform field welding only when called for on the plans and in accordance with 1072-20.”

“Remove paint or galvanizing at the location of field welds by blast cleaning (SSPC SP-6 finish), or hand (SSPC SP-2 finish) or power tool cleaning (SSPC SP-3 finish) just prior to welding. Clean sufficiently to prevent contamination of the weld by the paint.”

note: Refer to Appendix B for SSPC standards.

The NCDOT “Standard Specifications For Roads and Bridges JULY 2006” page 10-141 section 1072-20 makes reference to the ANSI/AWS/AASHTO Bridge Welding Code D-1.5 and states in section 1072-20 (B) **General** “Weld all structural steel in the shop or in the field for bridges, whether permanent or temporary, and perform all other work related to structural welding including, but not limited to, testing and inspection of welds, preparation of material, oxygen cutting, electrodes, shielding, and shear studs, meeting the requirements of the Bridge Welding Code. Weld other steel items in accordance with the requirements of the applicable AWS Welding Code.”

"Weld only where shown on the plans or where called for in the Specifications unless requesting and receiving written approval for additional welding."

Additional governing information pertaining to field welding can be found on contract documents such as NCDOT approved plans and special provisions.

Qualification of Personnel

For the purpose of field welding on NCDOT construction projects, all personnel must be tested and approved by the NCDOT Materials & Tests Unit (Steel Section). Prior to performing any welding activities, the qualified person must present the Welder ID card that was issued by the M & T Unit along with another photo ID, such as a driver’s license, to the NCDOT representative (i. e. Construction Inspector). Currently there are three levels of NCDOT field welder certification.

SIP Welder- This certification qualifies a welder to weld stay in place deck forms to girders.

Bridge Welder- This certification qualifies a welder to weld anything on a project except pipe less than 24 inches in diameter.

Pipe Welder: This certification qualifies a welder to weld anything on a project.

Additional information about welder certification can found at the following web address:
<http://www.ncdot.org/doh/operations/materials/pdf/fwcprocedure.pdf>

Qualification of Welds and Procedures

(7-21-09)
R43

SP10

Page 10-143, Subarticle 1072-20(D) Qualification of Welds and Procedures, replace the third sentence of the first paragraph with the following:

For all prequalified field welds, submit Welding Procedure Specifications (WPS) for each joint configuration for approval at least 30 days prior to performing any welding. In lieu of this, use the WPS provided and pre-approved by the Department. These pre-approved WPSs are available from the Materials and Tests Unit or at:

http://www.ncdot.org/doh/operations/materials/structural/appr_proc.html

Use non-prequalified welds only if approved by the Engineer. Submit WPS for all non-prequalified welds to the Engineer for approval. At no cost to the Department, demonstrate their adequacy in accordance with the requirements of the Bridge Welding Code.

Application

AWS D-1.5 Section 1.1.1 This code covers welding fabrication requirements applicable to welded highway bridges. The code is applicable to both shop and field fabrication of steel bridges and bridge components,

Workmanship

AWS D-1.5 Section 3.1.3 Welding shall not be done when the ambient temperature is lower than 0° F, when surfaces are wet or exposed to rain, snow, or high wind velocities, nor when welders are exposed to inclement conditions.

AWS D-1.5 Section 3.2.1 Surfaces and edges to be welded shall be smooth, uniform, and free from fins, tears, cracks, and other discontinuities which would adversely affect the quality or strength of the weld. Surfaces to be welded and surfaces adjacent to a weld shall also be free from loose or thick scale, slag, rust, moisture, grease, and other foreign material that would prevent proper welding or produce objectionable fumes. Mill scale that can withstand vigorous wire brushing, a thin rust-inhibitive coating, or antispatter compound may remain...

AWS D-1.5 Section 3.2.2 In all thermal cutting, the cutting flame shall be so adjusted and manipulated as to avoid cutting beyond (inside) the prescribed lines. The roughness of thermal cut surfaces shall be no greater than that defined by the American National Standards Institute, ANSI B46.1, Surface Texture. For material up to 100mm [4 in] thick, the maximum surface roughness value shall be 25 μ m (1000 μ in). Steel and weld metal may be thermally cut, provided a smooth and regular surface free from cracks and notches is secured, and provided that an accurate profile is secured by the use of a mechanical guide. Free-hand thermal cutting shall be done only where approved by the Engineer.

Workmanship (cont.)

AWS D-1.5 Section 3.2.4 Reentrant corners of base-metal cut edges shall be formed to provide a smooth transition with a radius of not less than 25mm [1 in] that meets the adjacent edges without offset or cutting past the point of tangency. The reentrant corners must be formed by thermal cutting, followed by grinding to meet the surface requirements of 3.2.2.

AWS D-1.5 Section 3.3.1 The parts to be joined by fillet welds shall be brought into as close contact as practical. The root opening shall not exceed 3/16" except in cases involving either shapes or plates 3" or greater in thickness if, after straightening and in assembly, the root opening cannot be closed sufficiently to meet this tolerance. ... If the root opening is greater than 1/16", the leg of the fillet weld shall be increased by the amount of the root opening or the Contractor shall demonstrate that the required weld size has been obtained.

AWS D-1.5 Section 3.3.1.2 The use of filler plates shall be prohibited except as specified on the drawings or as specially approved by the Engineer...

AWS D-1.5 Section 3.3.3 Parts to be joined by groove welds shall be carefully aligned. Where the parts are effectively restrained against bending due to eccentricity in alignment, the offset from theoretical alignment shall not exceed 10% of the thickness of the thinner part joined, but in no case shall be more than 1/8".

AWS D-1.5 Section 3.3.7 Tack welds shall be subject to the same quality requirements as the final welds.

AWS D-1.5 Section 3.3.8 Temporary welds shall be subject to the same WPS requirements as final welds. They shall be removed unless otherwise allowed by the Engineer. When they are removed, the surface shall be made flush with the original surface. There shall be no temporary welds in tension zones...

Weld Profiles

AWS D-1.5 Section 3.6.1.1 (in reference to fillet weld profiles) The convexity of a weld or individual surface bead shall not exceed 0.07 times the actual face width of the weld or individual bead, respectively, plus 1.5mm [0.06 in].

AWS D-1.5 Section 3.6.2 (in reference to groove weld profiles) Groove welds shall preferably be made with slight or minimum face reinforcement except as may be otherwise provided. In the case of butt and corner joints, the face reinforcement shall not exceed 3mm [1/8 in] in height and shall have gradual transition to the plane of the base surface... They shall be free of the discontinuities shown for butt joints...

AWS D-1.5 Section 3.6.5 Welds shall be free from overlap.

Repairing Welds

AWS D-1.5 Section 3.7.2 The Contractor has the option of either repairing an unacceptable weld, or removing and replacing the entire weld... If the Contractor elects to repair the weld, it shall be corrected as follows:

AWS D-1.5 Section 3.7.2.1 **Overlap or Excessive Convexity.** Excess weld metal shall be removed.

AWS D-1.5 Section 3.7.2.2 **Excessive Concavity of Weld or Crater, Undersize Welds, Undercutting.** Surfaces shall be prepared (see 3.11) and additional weld metal deposited.

AWS D-1.5 Section 3.7.2.3 **Excessive Weld Porosity, Excessive Slag Inclusions, Incomplete Fusion.** Unacceptable portions shall be removed and re-welded.

AWS D-1.5 Section 3.7.2.4 **Cracks in Weld or Base Metal.** The extent of the crack shall be ascertained by use of MT, PT, or other equally positive means; the metal shall be removed for the full length of the crack plus 500mm [2 in] beyond each end of the crack, and re-welded.

Weld Cleaning

AWS D-1.5 Section 3.11.1 **In-Process Cleaning.** Before welding over previously deposited metal, all slag shall be removed and the weld and adjacent base metal shall be brushed clean. This requirement shall apply not only to successive layers but also to successive beads and to the crater area when welding is resumed after an interruption...

AWS D-1.5 Section 3.11.2 **Cleaning of Completed Welds.** Slag shall be removed from all completed welds, and the weld and adjacent base metal shall be cleaned by brushing or other suitable means. Tightly adherent spatter remaining after the cleaning operation shall be acceptable unless its removal shall be required for the purpose of NDT or painting. Welded joints shall not be painted until after welding has been completed and the weld has been accepted.

Backing Bar

AWS D-1.5 Section 3.13.5 Steel backing shall be placed and held in intimate contact with the base metal. The maximum gap between steel backing and the base metal at the weld root shall be 2 mm (1/16 in).

Preheat and Interpass Temperature

Unless stated otherwise on the approved welding procedure, all preheat temperatures on NCDOT projects shall be 100° F.

AWS D-1.5 Section 4.2.7 When the base metal is below the temperature listed for the welding process being used and the thickness of material being welded, it shall be preheated (except as otherwise provided) in such a manner that the steel on which weld metal is being deposited is at or above the specified minimum temperature for a distance equal to the thickness of the part being welded, but not less than 75mm [3 in] in all directions from the point of welding.

AWS D-1.5 Section 4.2.8 **Preheat and Interpass Temperature Requirements** When the base metal temperature is below 0° C [32° F], the base metal shall be heated to at least 20° C [70° F], and this minimum temperature shall be maintained during welding.

Electrode Storage

AWS D-1.5 Section 4.5.2 All electrodes having low hydrogen coverings conforming to AWS 5.1/A5.1M shall be purchased in hermetically sealed containers... Immediately after opening the hermetically sealed container or removal of the electrodes from drying ovens, electrodes shall be stored in ovens held at a temperature of at least 120°C [250°F]. After the opening of hermetically sealed containers or removal from drying or storage ovens, electrode exposure to the atmosphere shall not exceed the requirements of 4.5.2.1.

AWS D-1.5 Section 4.5.2.1 Electrodes exposed to the atmosphere upon removal from drying or storage ovens or hermetically sealed containers shall be used within the time limit shown in Table 4.7...

AWS D-1.5 Section 4.5.2.2 Electrodes exposed to the atmosphere for periods less than those allowed by Table 4.7 may be returned to a holding oven maintained at 250° F minimum and after a minimum period of four hours at that temperature may be reissued. The Provisions of 4.5.4 shall apply.

AWS D-1.5 Section 4.5.4 Electrodes that conform to the provisions of 4.5.2 shall be re-dried no more than one time. Electrodes that have been wet shall not be used.

AWS D-1.5 Table 4.7 illustrates the following:

“Allowable Atmospheric Exposure of Low-Hydrogen SMAW Electrodes”

Electrode	Hours
E70XX	4 max.
E80XX	2 max.
E70 or E80XXR or H4R	9 max.

Weld Acceptance Criteria

AWS D-1.5 Section 6.26.1 All welds shall be visually inspected. A weld shall be acceptable by visual inspection if it conforms to the following requirements:

AWS D-1.5 Section 6.26.1.1 The weld shall have no cracks.

AWS D-1.5 Section 6.26.1.2 Thorough fusion shall exist between adjacent layers of weld metal and between weld metal and base metal.

AWS D-1.5 Section 6.26.1.3 All craters are to be filled to the full cross section of the weld...

AWS D-1.5 Section 6.26.1.4 Weld profiles shall be in conformance with 3.6.

AWS D-1.5 Section 6.26.1.5 In primary members, undercut shall be no more than 0.25mm [0.01 in] deep when the weld is transverse to tensile stress under any design loading condition. Undercut shall be no more than 1mm [1/32 in] deep for all other cases.

Porosity limitation guidelines (AWS D-1.5 Section 6.26.1.6) are too complex to be presented in this manual. Contact the M&T Unit (Steel Section) for technical assistance regarding discontinuities of this type.

AWS D-1.5 Section 6.26.1.7 A fillet weld in any single continuous weld may under run the nominal fillet weld size specified by 2mm [1/16 in] without correction, provided that the undersize portion of the weld does not exceed 10% of the length of the weld.

AWS D-1.5 C-6.26.1 Visual Inspection. All welds are required to be visually inspected. Visual inspection is performed before welding, during welding, and after welding, as necessary to ensure that the requirements of the Contract Documents are met and that all welds conform to the visual requirements of this sub-clause. The Inspector is not required to inspect each weld pass, but periodically observe welding with sufficient frequency to verify the skills of the welder, proper joint preparation, WPS variables, and the visual quality of typical root, intermediate, and final weld passes. In addition to inspection before and during welding, the Inspector is expected to visually inspect every completed weld to verify conformance to these requirements. See C6.5.

AWS D-1.5 C-6.5 Each welder, welding operator and tack welder should be a visual inspector of his or her own work. Welding personnel should know when welds display visual discontinuities not acceptable under the Code. Because each weld pass of every weld is to be inspected by the welder, and the inspector monitors welding in progress and makes a detailed inspection of completed welds, major weld defects or gross nonconformance to the Code should be detected.

Stud Welding

Contact the NCDOT M&T Unit (Steel Section) when "automatically timed stud welding equipment" is being used.

AWS D-1.5 Section 7.4.1 At the time of welding, the studs shall be free from rust, rust pits, scale, oil, moisture, and other deleterious matter that would adversely affect the welding operations.

AWS D-1.5 Section 7.4.2 The stud base shall not be painted, galvanized, nor cadmium-plated prior to welding.

AWS D-1.5 Section 7.5.5 At the option of the Contractor, studs may be fillet welded by the SMAW, provided the following requirements are met:

AWS D-1.5 Section 7.5.5.3 The stud base shall be prepared so that the base of the stud fits against the base metal.

AWS D-1.5 Section 7.5.5.4 All rust and mill scale at the location of the stud shall be removed from the base metal by grinding. The end of the stud shall also be clean.

Equipment Requirements

Any qualified person intending to perform welding on an NCDOT project shall arrive at the job site with all of the appropriate equipment which includes but is not limited to a **welding machine** that has an adequate power range to produce the amperage necessary to satisfy the WPS requirements, an **electrode storage oven** to stay within the guidelines of the exposure limits of the welding consumables, a **grinder** that is suitable for preparing the base metal in the area that is to be welded, a **torch** or other preheating device that can satisfactorily raise the temperature of the base metal in the area to be welded to the range that is specified in the WPS, approved **low hydrogen electrodes** that are in a hermetically sealed container or in an active electrode storage oven, **clamps or other equipment** that is necessary to properly cut, fit and assemble the material to be welded and clean the completed weld. Failure to produce this or other equipment that is needed to complete the work within specifications could result in the Welding Contractor not being permitted to start welding.

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION H-PILE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: Vertical – up

Root Treatment: Back Gouge with a grinder to sound metal prior to applying the back weld.

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-150 120-200	20-23 21-24	6-9 ipm 6-10 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Any distorted material in the web or flanges that was damaged by the pile driving process shall be removed.

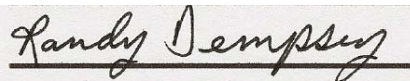
Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up.

The theoretical alignment of the pieces joined shall be within 10% of the thickness of the material, as required by the AWS D1.5 Bridge Welding Code.

Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description H-PILE

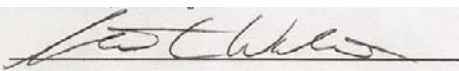
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

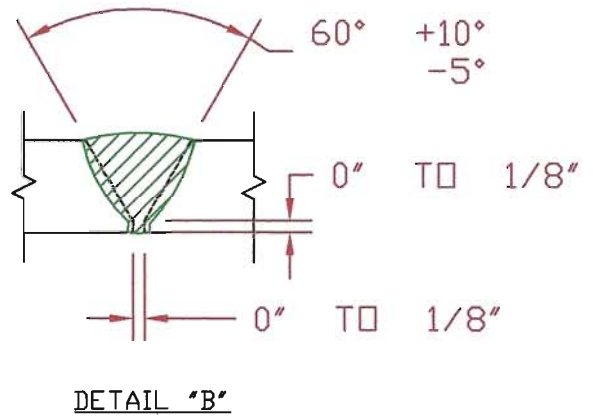
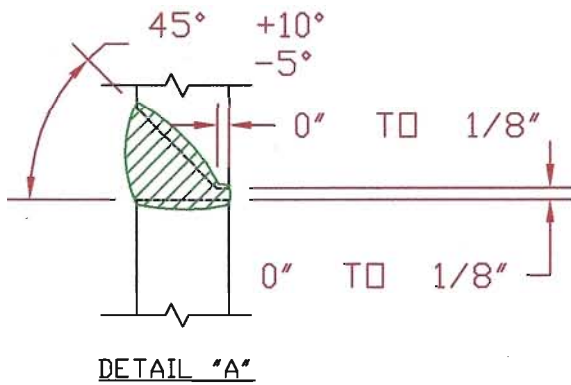
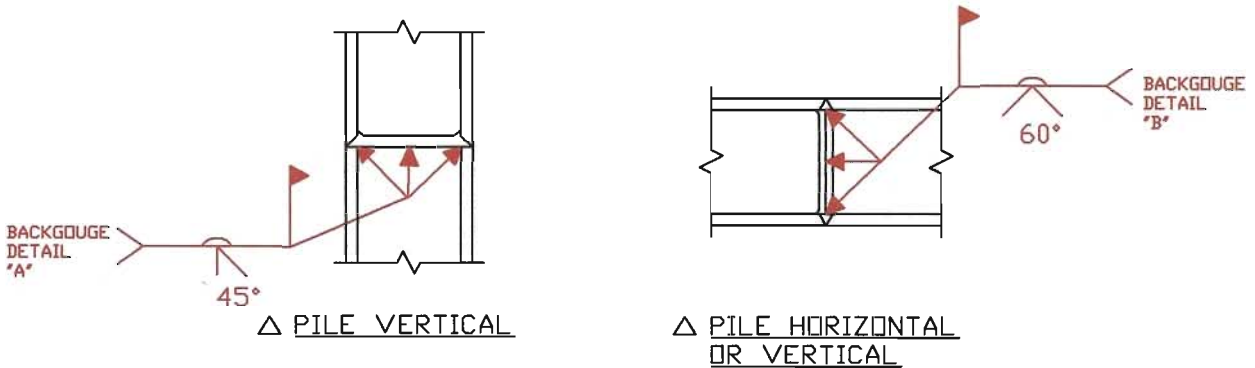
WPS #: 080508001

Authorized By: Steve Walton, Metals Engineer

Revision #: 4

Signature: 

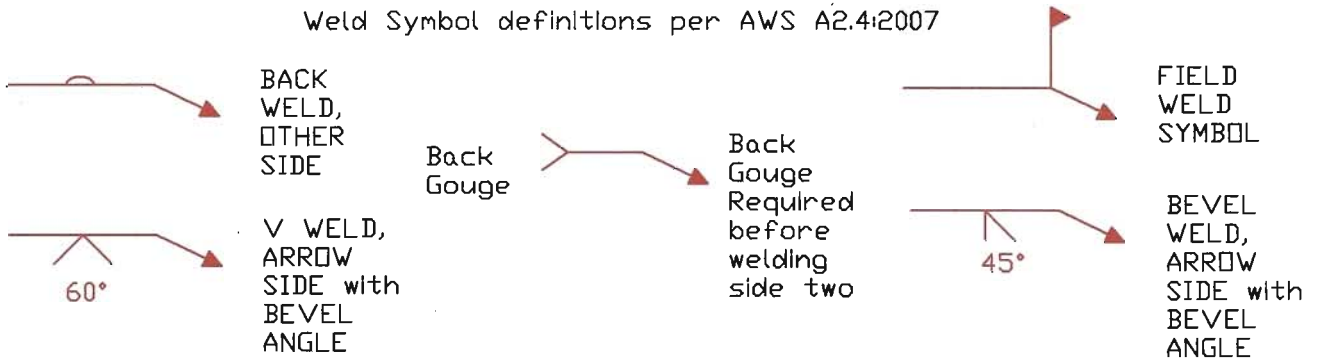
WPS H-PILE 080508001 R4 JOINT DETAIL ATTACHMENT



Δ POSITION OF PILE DURING WELDING

H-PILE SPLICE DETAILS

Weld Symbol definitions per AWS A2.4:2007



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION STEEL GIRDER BEARING PLATE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

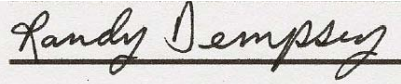
COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

Care shall be taken to not exceed 250° in the proximity of the Elastomeric Bearing material.

WPS Description: Steel Girder Bearing Plate

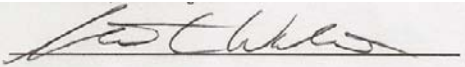
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

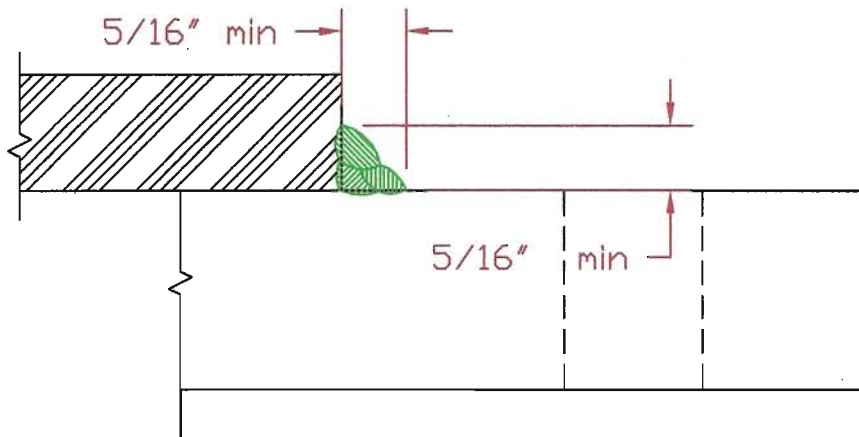
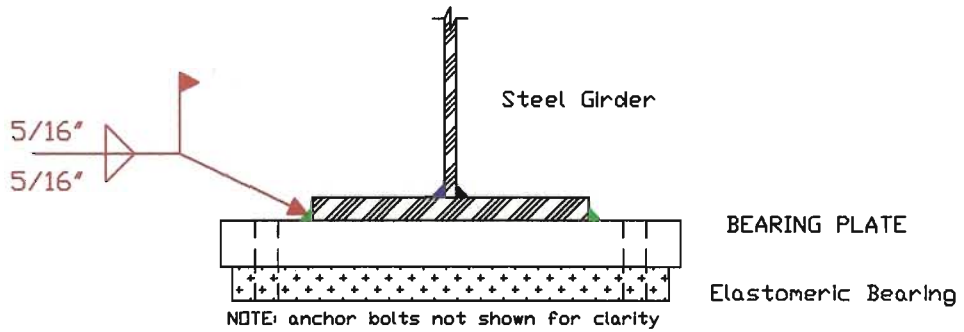
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Authorized By: Steve Walton, Metals Engineer

Revision #: 4

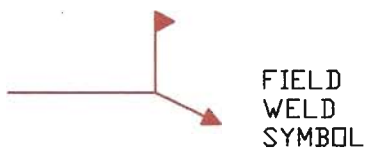
Signature: 

WPS STEEL GIRDER BEARING PLATE 080708002 R4
JOINT DETAIL ATTACHMENT



STEEL GIRDER
BEARING PLATE DETAILS

Weld Symbol definitions per AWS A2.4:2007



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION PIPE-PILE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.1

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.1, Sections 2 thru 6

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass: both Position of Weld: Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

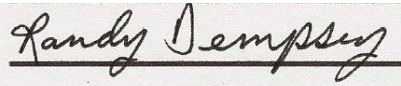
Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-150 120-200	20-23 21-24	6-9 ipm 6-10 ipm		Vertical Orientation, SEE ATTACHMENT 1 Horizontal Orientation, SEE ATTACHMENT 2

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:
Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: PIPE PILE

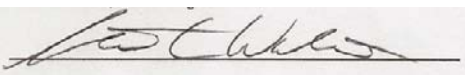
Written By: Randy Dempsey, CWI/CWE, TT IV

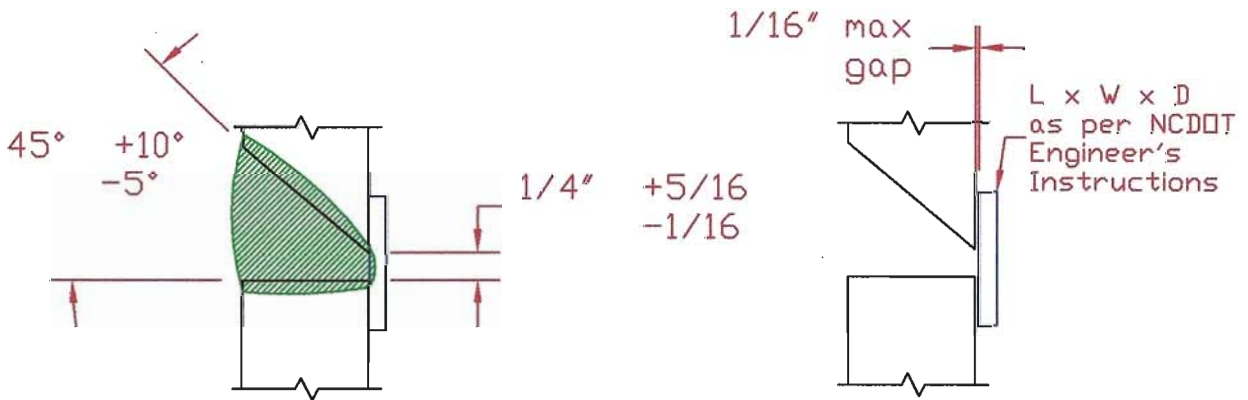
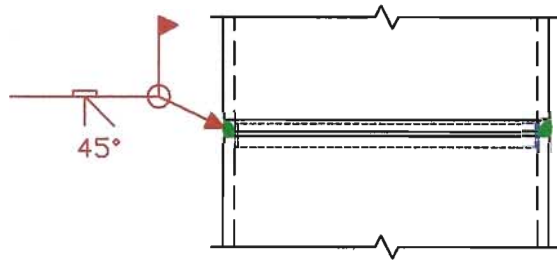
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WPS #: 082508003

Authorized By: Steve Walton, Metals Engineer

Revision #: 5

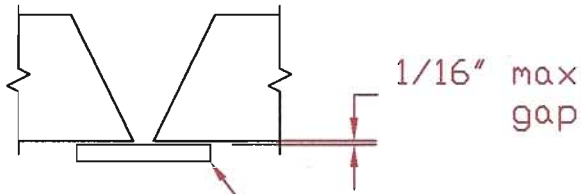
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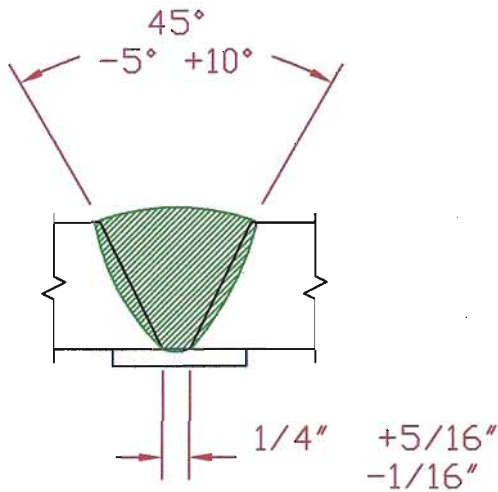
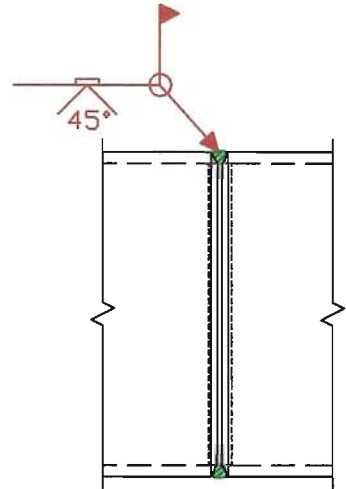
VERTICAL ORIENTATION PIPE-PILE SPLICE DETAILS

Weld Symbol definitions per AWS A2.4:2007





L x W x D
as per NCDOT
Engineer's
Instructions



HORIZONTAL ORIENTATION PIPE-PILE SPLICE DETAILS

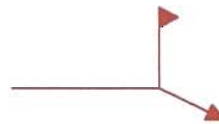
Weld Symbol definitions per AWS A2.4:2007



BACKING
BAR



WELD ALL
AROUND



FIELD WELD SYMBOL



BEVEL WELD, ARROW
SIDE with BEVEL
ANGLE

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION CONCRETE GIRDER SOLE PLATE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

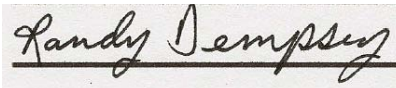
COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

Care shall be taken to not exceed 250° in the proximity of the Elastomeric Bearing material and 300° in the proximity of the concrete.

WPS Description: Concrete Girder Sole Plate

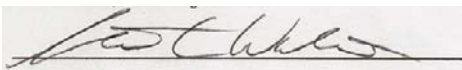
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

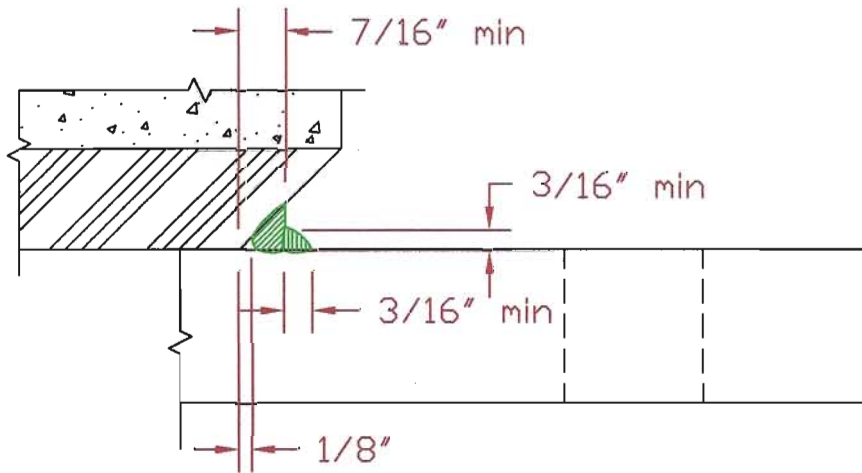
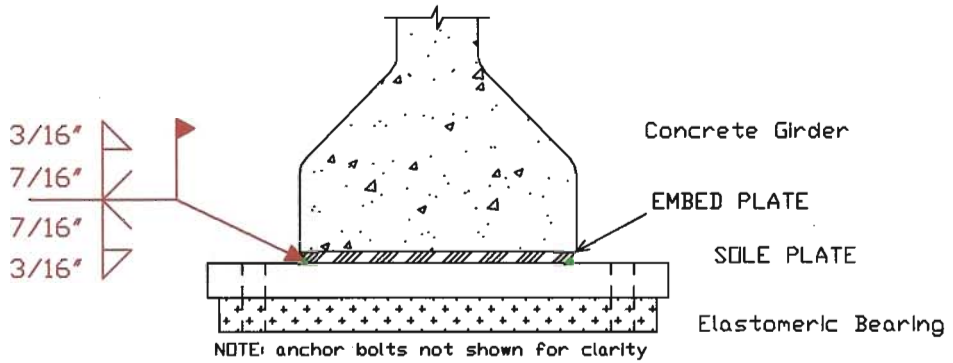
WPS #: 082508004

Authorized By: Steve Walton, Metals Engineer

Revision #: 4

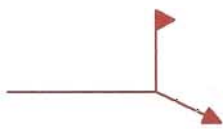
Signature: 

WPS CONCRETE GIRDER SOLE PLATE 082508004 R4
 JOINT DETAIL ATTACHMENT



CONCRETE GIRDER
 SOLE PLATE DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD
 WELD
 SYMBOL

Size of Fillet	3/16"	
Depth of Groove	7/16"	
Depth of Groove	7/16"	
Size of Fillet	3/16"	

Groove Weld with
 Reinforcing Fillet
 Weld, Both Sides

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION STEEL GIRDER SIP ANGLE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass single Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

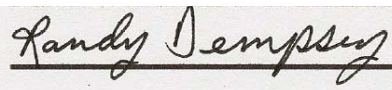
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Repair all weld discontinuities. Clean the completed weld of all debris, slag and spatter.

WPS Description: Steel Girder SIP Angle

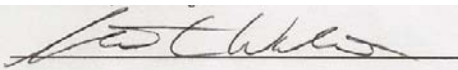
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

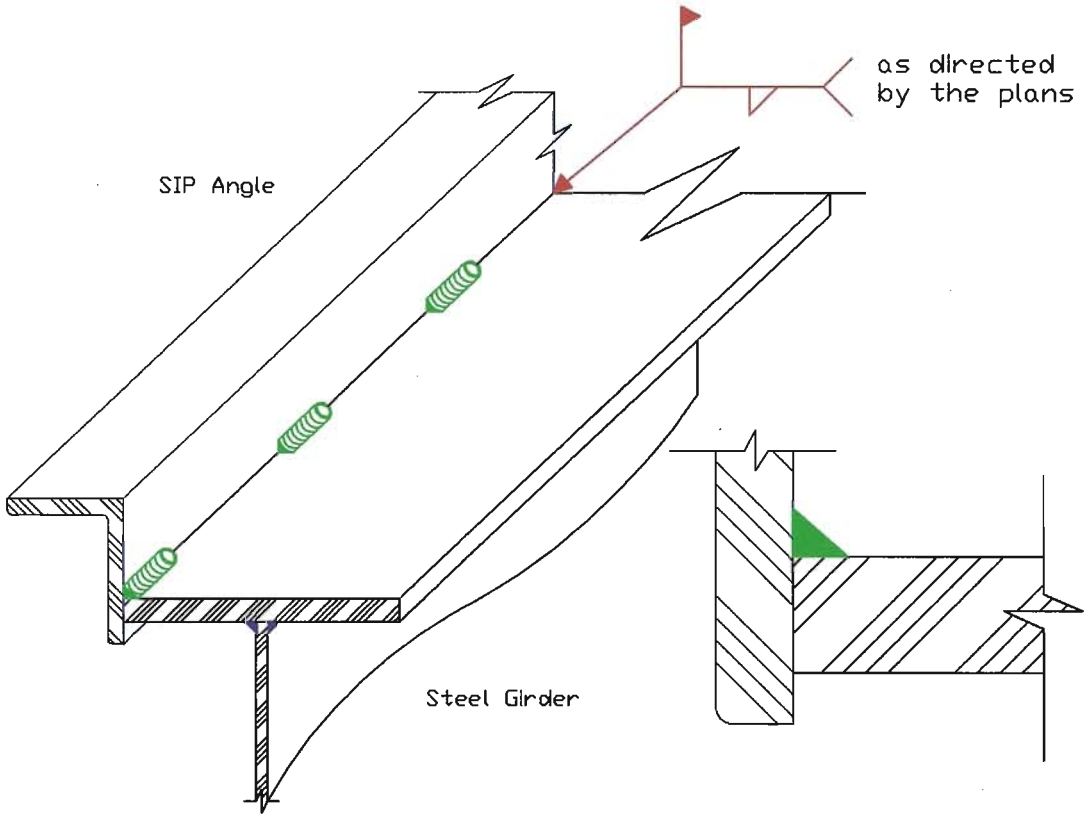
WPS #: 010909005

Authorized By: Steve Walton, Metals Engineer

Revision #: 5

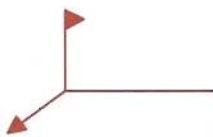
Signature: 

WPS STEEL GIRDER SIP ANGLE 010909005 R5
JOINT DETAIL ATTACHMENT



STEEL GIRDER
SIP ANGLE DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD
SYMBOL



FILLET WELD,
ARROW SIDE

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION CONCRETE GIRDER SIP ANGLE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass single Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 50° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

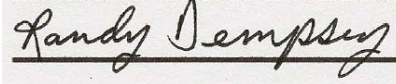
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	50°
Over 3/4" to 1 1/2"	70°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Repair all weld discontinuities. Clean the completed weld of all debris, slag and spatter.

WPS Description: Concrete Girder SIP Angle

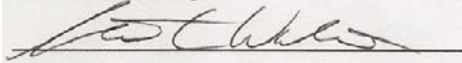
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

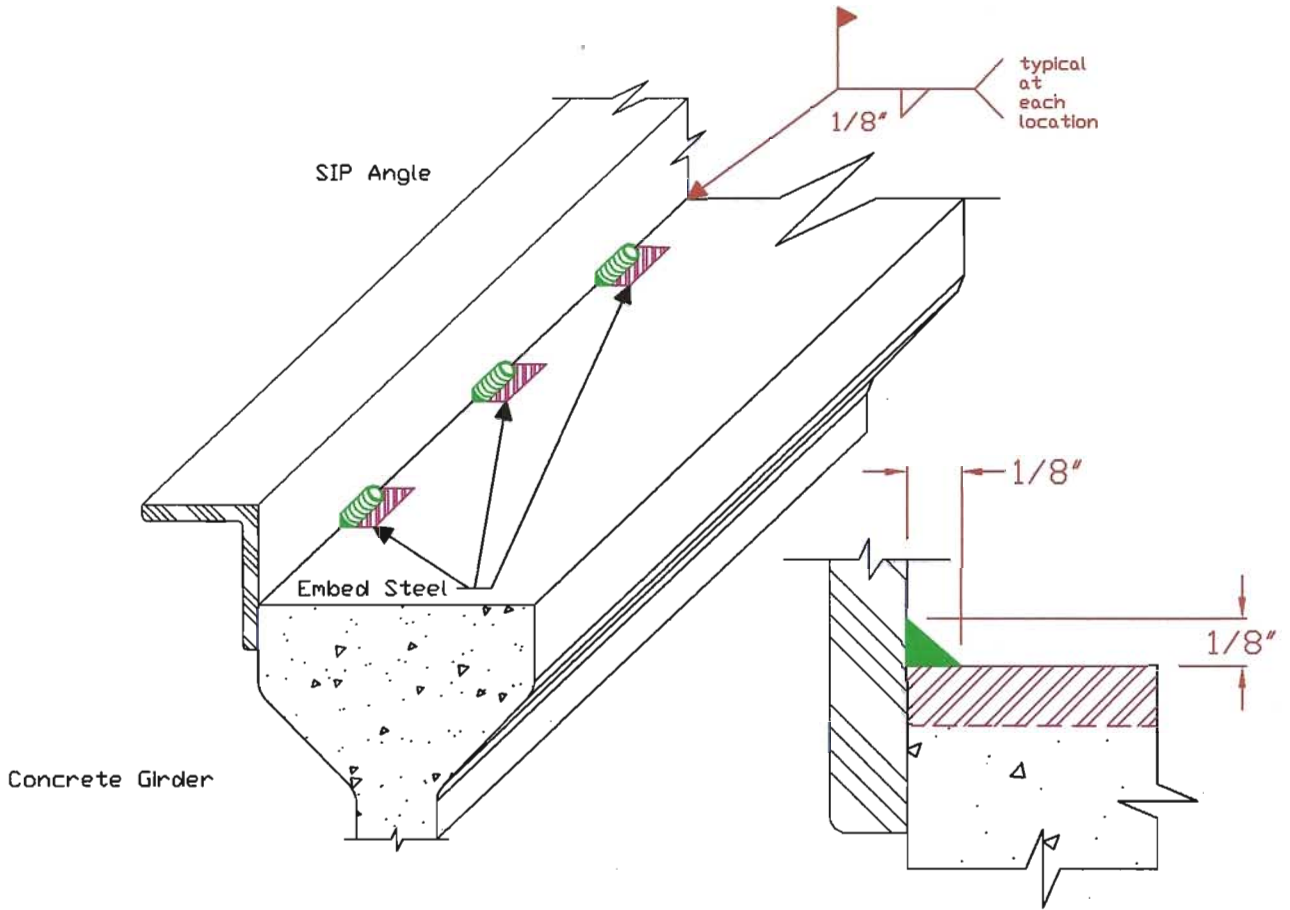
WPS #: 011609006

Authorized By: Steve Walton, Metals Engineer

Revision #: 4

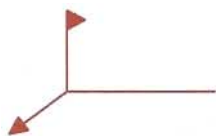
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WPS CONCRETE GIRDER SIP ANGLE 011609006 R4
JOINT DETAIL ATTACHMENT

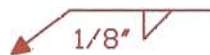


CONCRETE GIRDER
SIP ANGLE DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD SYMBOL



FILLET WELD, ARROW
SIDE with WELD SIZE

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION STUD WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: Vertical up

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-150 120-200	20-23 21-24	6-9 ipm 6-10 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

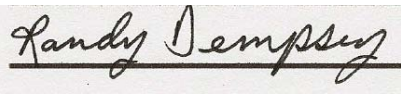
Remove the protrusion from the bottom of the stud and all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Stud Welding

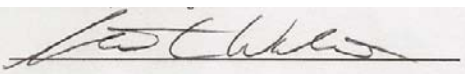
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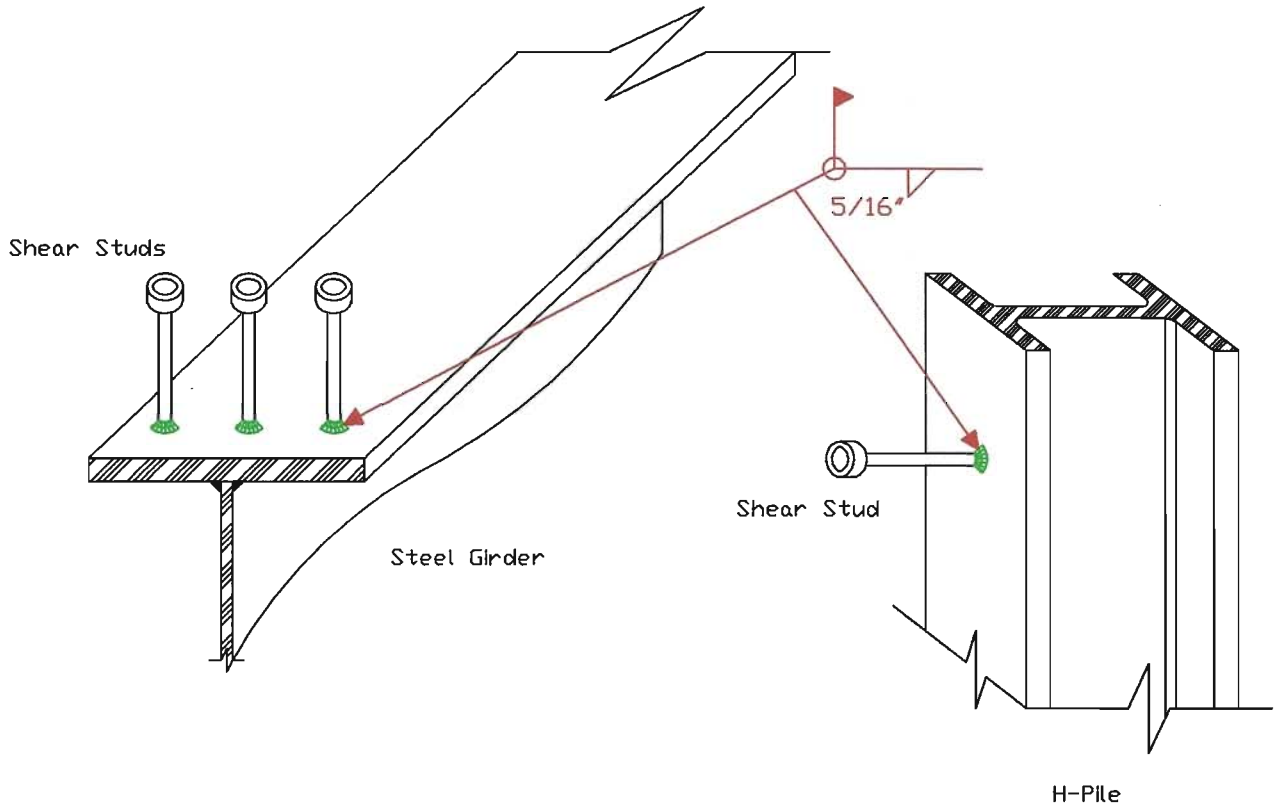
Revision #: 4

Written By: Randy Dempsey, CWI/CWE, Transportation Technician IV

Signature: 

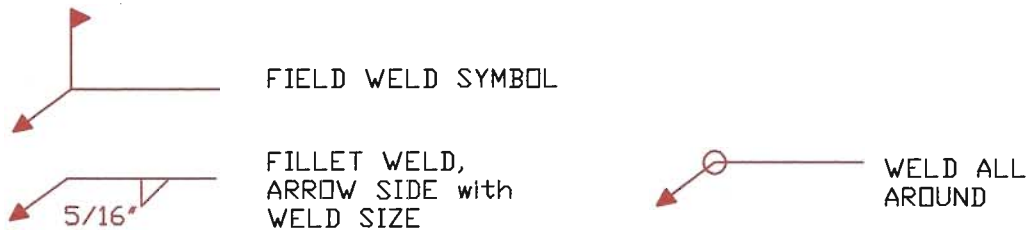
Authorized By: Steve Walton, Metals Engineer

Signature: 



STUD WELDING DETAILS

Weld Symbol definitions per AWS A2.4:2007



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION FILLET WELD CERTIFICATION TEST (PREREQUISITE FOR GROOVE TEST) WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, 3/8" THICK

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Vertical

Welding Current: DC Polarity: Positive Progression: Vertical - up

Root Treatment: N/A

Preheat Temp: 50° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min Temp.
Up to 3/4"	50°

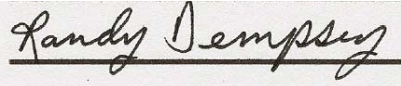
COMMENTS:

Remove all rust and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag and spatter between passes. Clean the completed weld of all debris, slag and spatter.

The fillet weld size shall be as directed by the examination proctor.

WPS Description Fillet Weld Certification Test

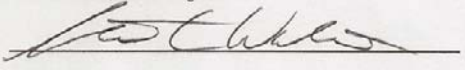
Written By: Randy Dempsey, CWI/CWE, Transportation Technician IV

Signature: 

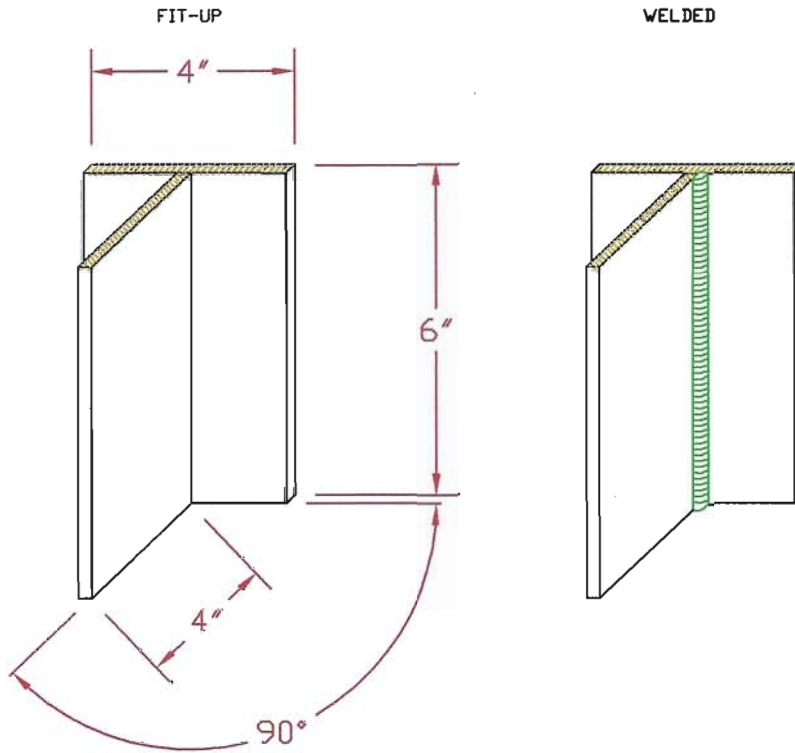
WPS #: 040209008

Authorized By: Steve Walton, Metals Engineer

Revision #: 3

Signature: 

WPS FILLET WELD CERTIFICATION TEST 040209008 R3
prerequisite for groove test
JOINT DETAIL ATTACHMENT



FILLET WELD
TEE JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION 3G-4G PLATE CERTIFICATION TEST (BRIDGE WELDER) WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, 3/8" Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass Multiple Position of Weld Vertical & Overhead

Welding Current: DC Polarity: Positive Progression: Vertical – up

Root Treatment: N/A

Preheat Temp: 50° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	50°

COMMENTS:

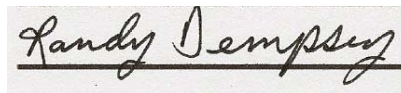
The backing bar must be in close contact with the test material.

Remove all rust and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag and spatter between passes. Clean the completed weld of all debris, slag and spatter.

Fill the groove to the full cross section of the member.

WPS Description 3G-4G Plate Certification Test

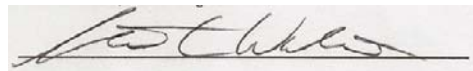
Written By: Randy Dempsey, CWI/CWE, Transportation Technician IV



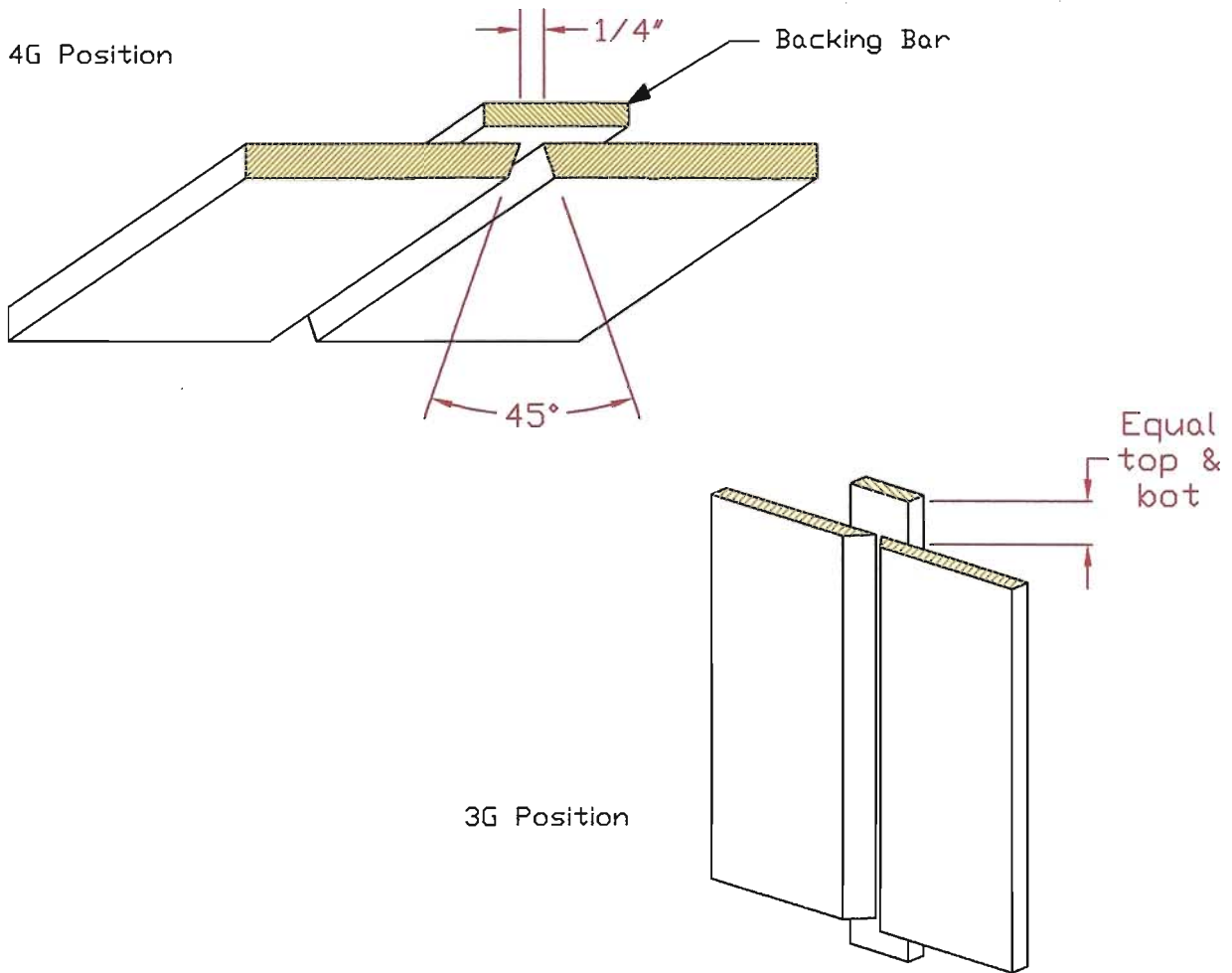
WPS #: 040209009

Signature: _____
Authorized By: Steve Walton, Metals Engineer

Revision #: 3

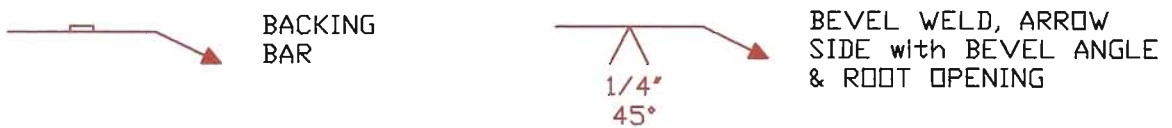
Signature: 

WPS 3G-4G PLATE CERTIFICATION TEST 040209009 R3
JOINT DETAIL ATTACHMENT



3G-4G GROOVE WELD
JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION 6G PIPE CERTIFICATION TEST (PIPE WELDER) WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.1

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.1, Sections 2 thru 6

Material Specifications: ASTM A-36

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass Multiple Position of Weld Flat, Horizontal Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: Vertical-up

Root Treatment: N/A

Preheat Temp: 50° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	50°

COMMENTS:

The backing ring must be in close contact with the test material.

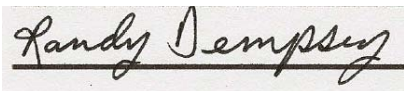
Remove all rust and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag and spatter between passes. Clean the completed weld of all debris, slag and spatter.

Fill the groove to the full cross section of the member.

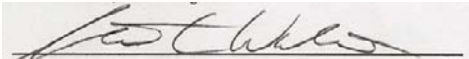
WPS Description: 6G Pipe Certification Test

Written By: Randy Dempsey, CWI/CWE, TT IV

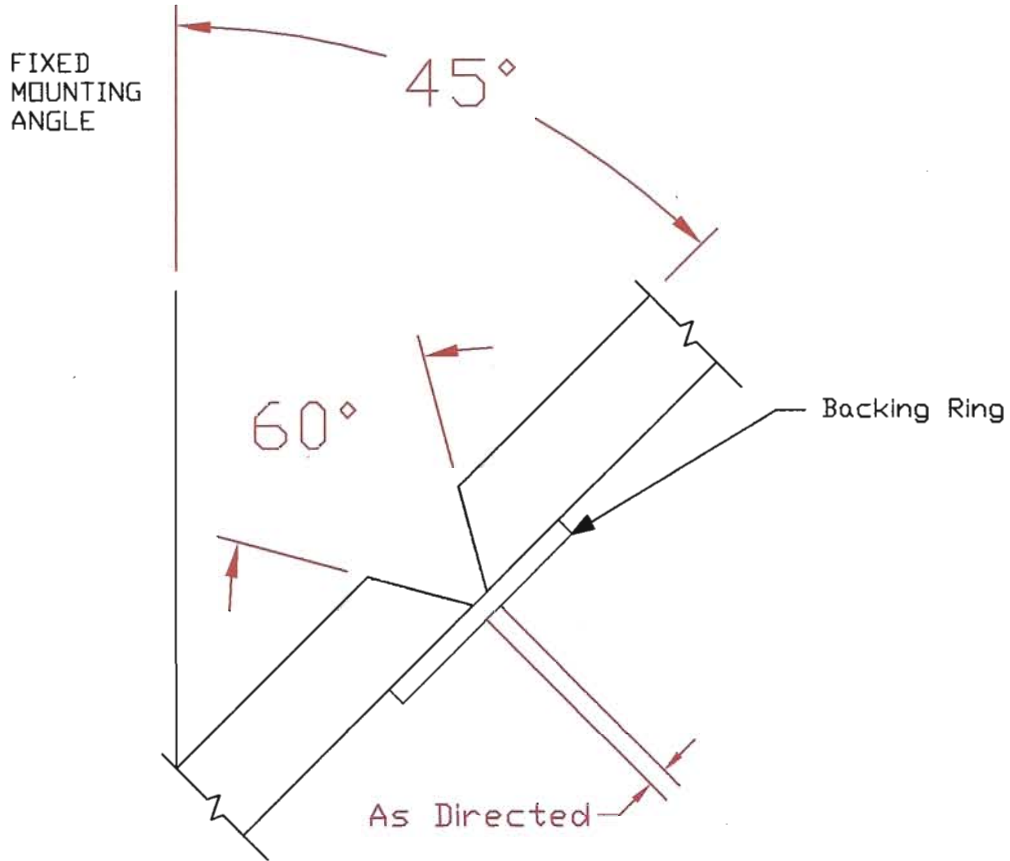
WPS #: 040209010

Signature: 
Steve Walton, Metals Engineer

Revision #: 3

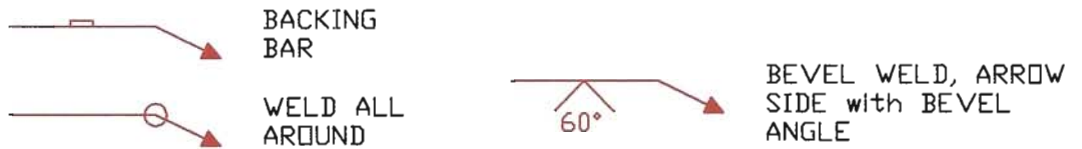
Authorized By: 

WPS 6G PIPE CERTIFICATION TEST 040209010
R3 JOINT DETAIL ATTACHMENT



6G PIPE JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

SIP WELDER CERTIFICATION TEST

WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, 3/8" THICK

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 50° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	50°

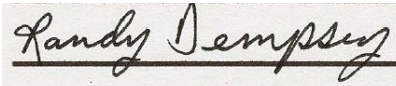
COMMENTS:

Remove all rust and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag and spatter between passes. Clean the completed weld of all debris, slag and spatter.

The fillet weld size shall be as directed by the examination proctor.

WPS Description: SIP Welder Certification Test

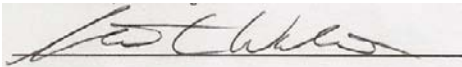
Written By: Randy Dempsey, CWI/CWE, Transportation Technician IV

Signature: 

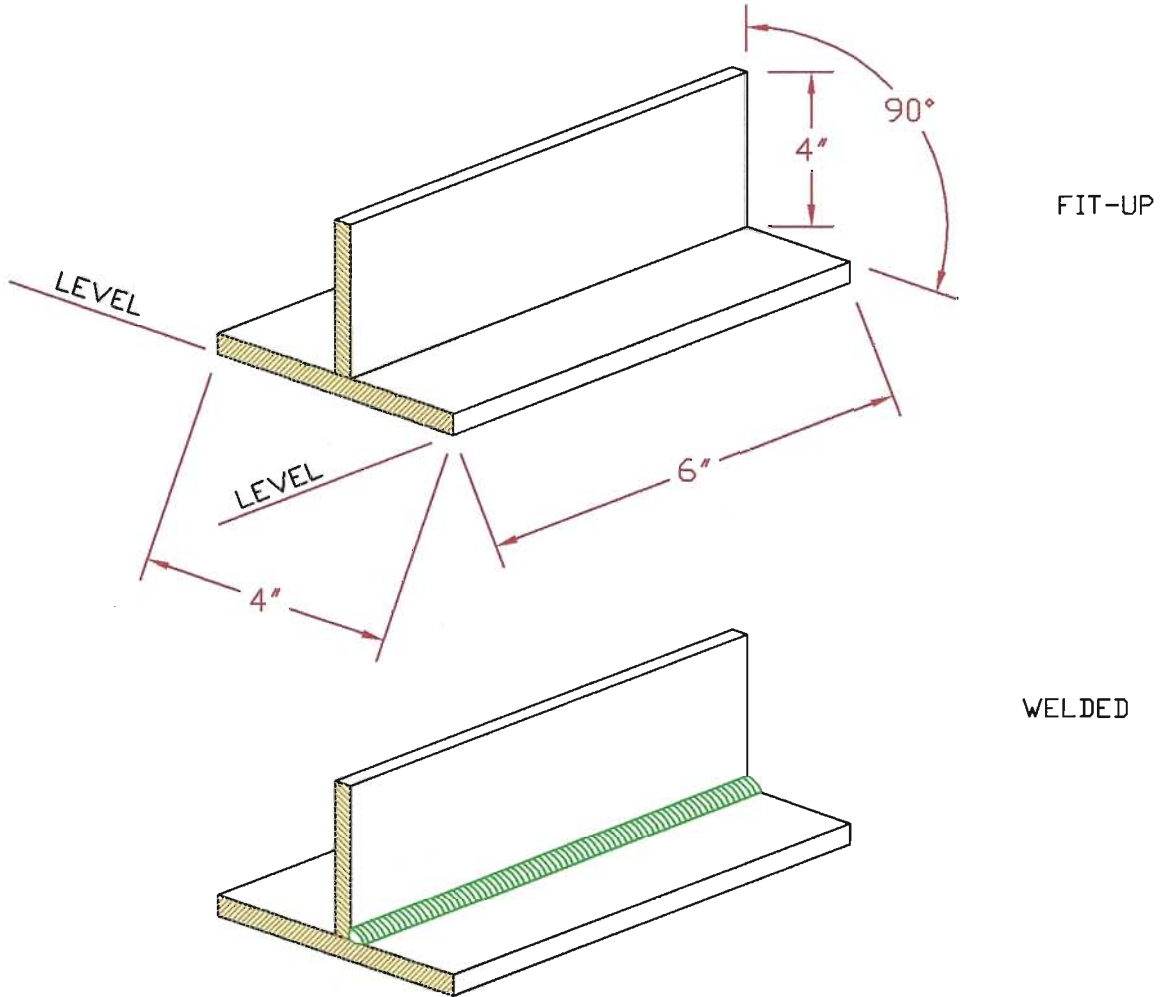
WPS #: 040209011

Authorized By: Steve Walton, Metals Engineer

Revision #: 3

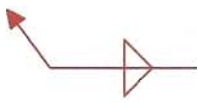
Signature: 

WPS SIP WELDER CERTIFICATION TEST 0402090011 R3
JOINT DETAIL ATTACHMENT



SIP WELDER CERTIFICATION TEE JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



FILLET WELD, BOTH
SIDES OF ARROW

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION ENCASEMENT PIPE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.1

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.1, Sections 2 thru 6

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-150 120-200	20-23 21-24	6-9 ipm 6-10 ipm		SEE ATTACHMENT

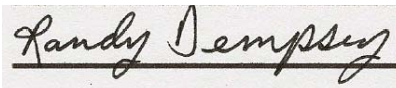
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Encasement-Pipe

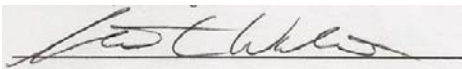
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

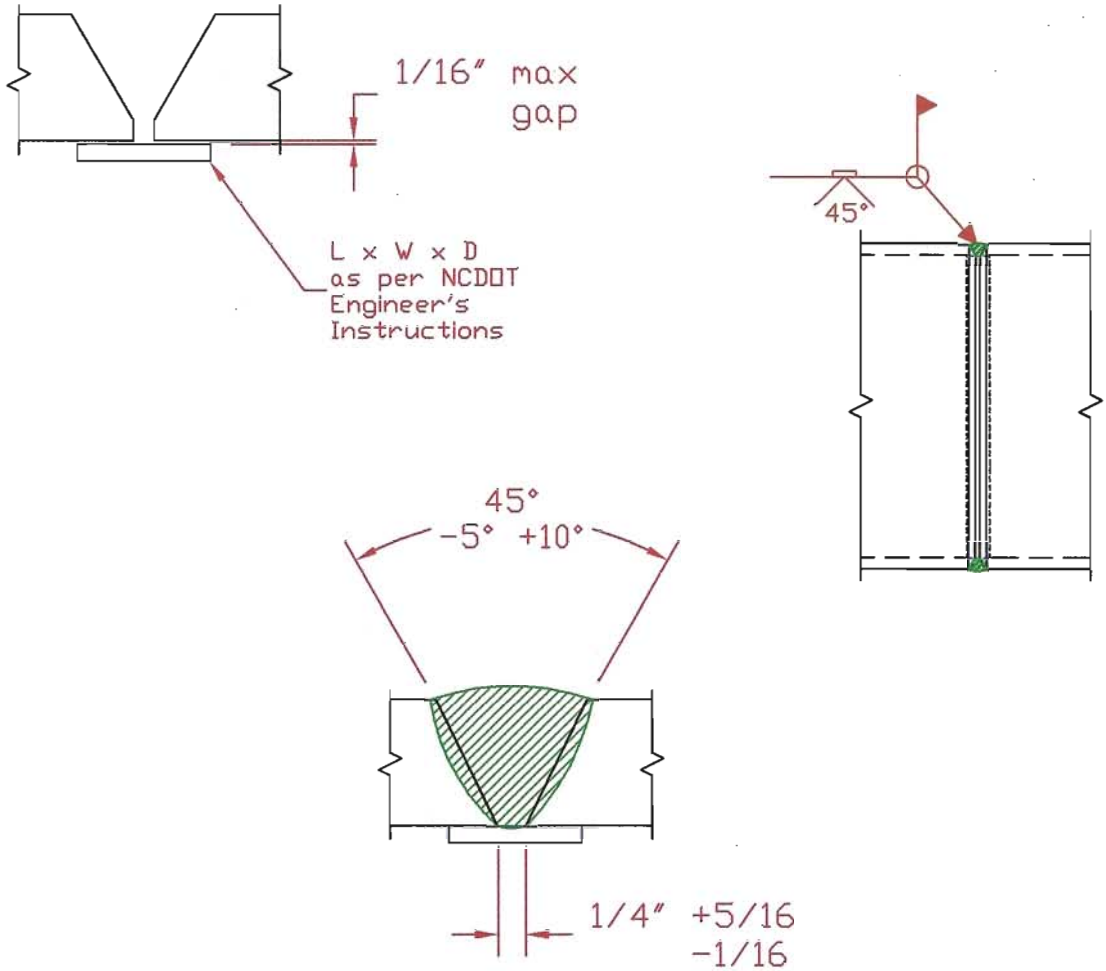
WPS #: 081109012

Authorized By: Steve Walton, Metals Engineer

Revision #: 3

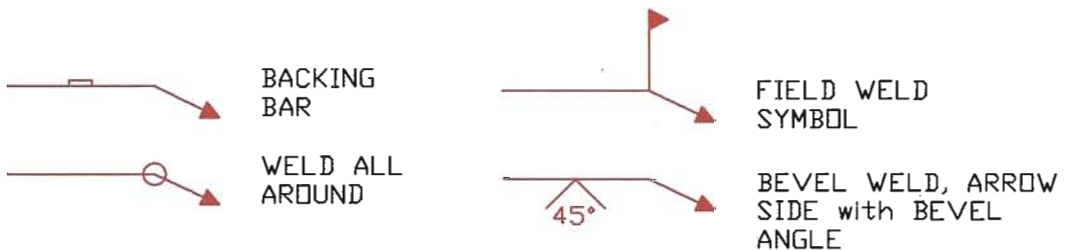
Signature: 

WPS ENCASEMENT-PIPE 081109012 R3
JOINT DETAIL ATTACHMENT



ENCASEMENT-PIPE SPLICE DETAILS

Weld Symbol definitions per AWS A2.4:2007



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION STEEL GIRDER BEARING PLATE WEATHERING STEEL (UNPAINTED) WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36W, A572W, (A709W-36, 50), (M270W-GR250, 345) Unlimited Thickness
[weathering steel]

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.5 Classification: E-8018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

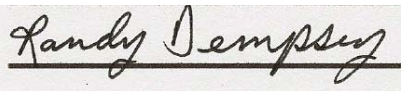
COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

Care shall be taken to not exceed 250° in the proximity of the Elastomeric Bearing material.

WPS Description: Steel Girder Bearing Plate Weathering Steel (unpainted)

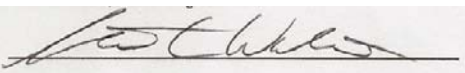
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

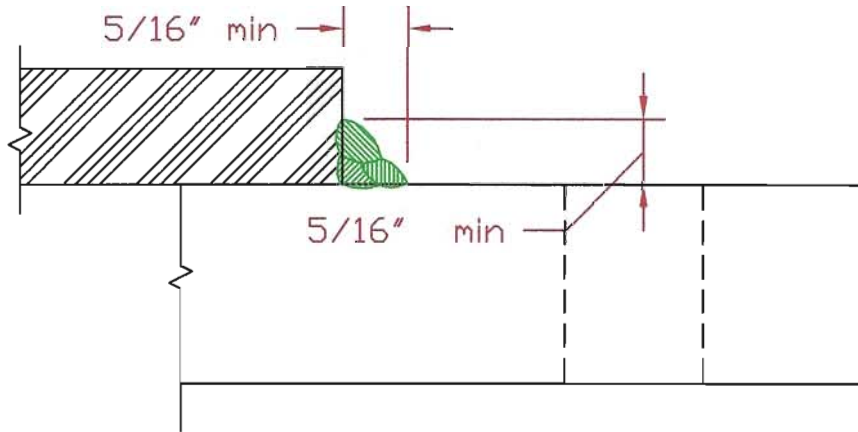
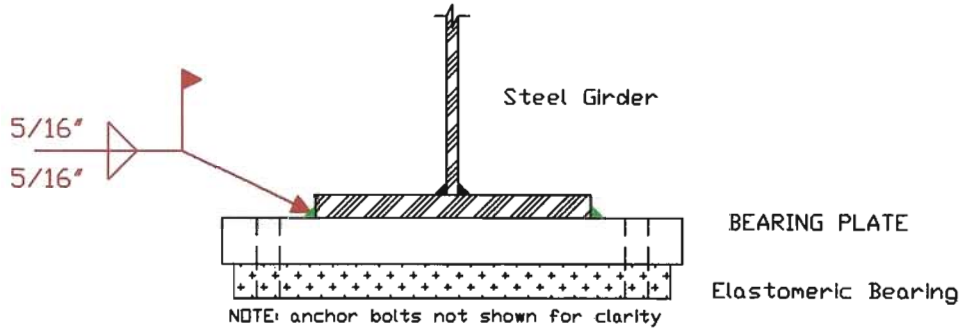
WPS #: 021510013

Authorized By: Steve Walton, Metals Engineer

Revision #: 2

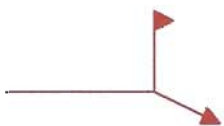
Signature: 

WPS STEEL GIRDER BEARING PLATE
 (weathering steel-unpainted)
 021510013 R2
 JOINT DETAIL ATTACHMENT

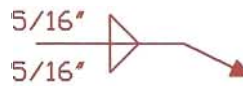


STEEL GIRDER
BEARING PLATE DETAILS
(weathering steel)

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD SYMBOL



FILLET WELD, BOTH SIDES
 with WELD SIZE

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION OVERHANG BRACKET WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass single Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-140 120-200	20-23 21-24	6-9 ipm 6-10 ipm		SEE ATTACHMENT

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

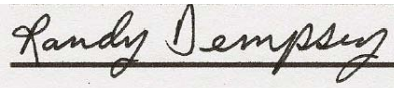
COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Repair all weld discontinuities. Clean the completed weld of all debris, slag and spatter.

NO WELDING IS ALLOWED IN THE TENSION AREA OF THE FLANGE!!!

WPS Description: Overhang Bracket

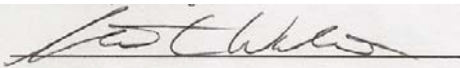
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

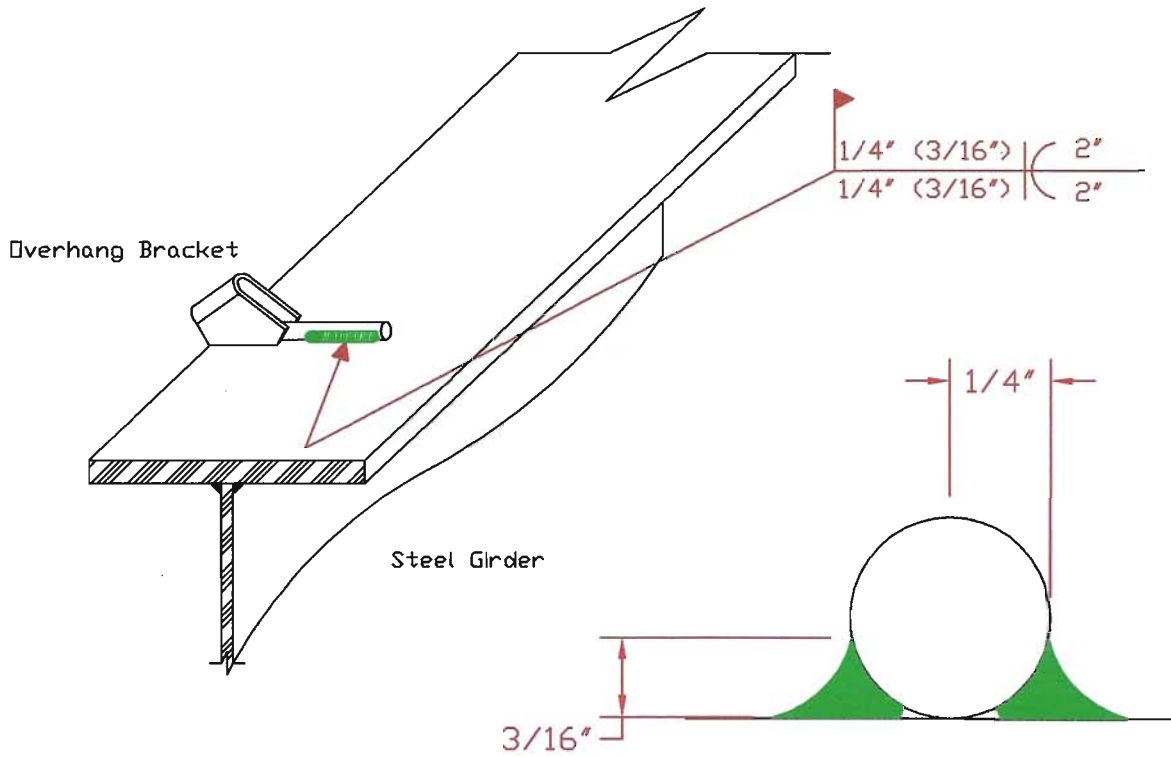
WPS #: 021510014

Authorized By: Steve Walton, Metals Engineer

Revision #: 2

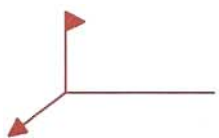
Signature: 

WPS OVERHANG BRACKET 021510014 R2
JOINT DETAIL ATTACHMENT



OVERHANG BRACKET
DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD SYMBOL



Double-Flare
Bevel-Groove with Weld
Length

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION SIP STRAP WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass single Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 50° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

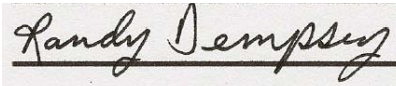
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	50°
Over 3/4" to 1 1/2"	70°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Repair all weld discontinuities. Clean the completed weld of all debris, slag and spatter.

WPS Description: SIP Strap

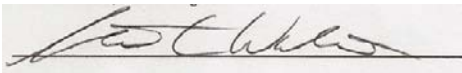
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

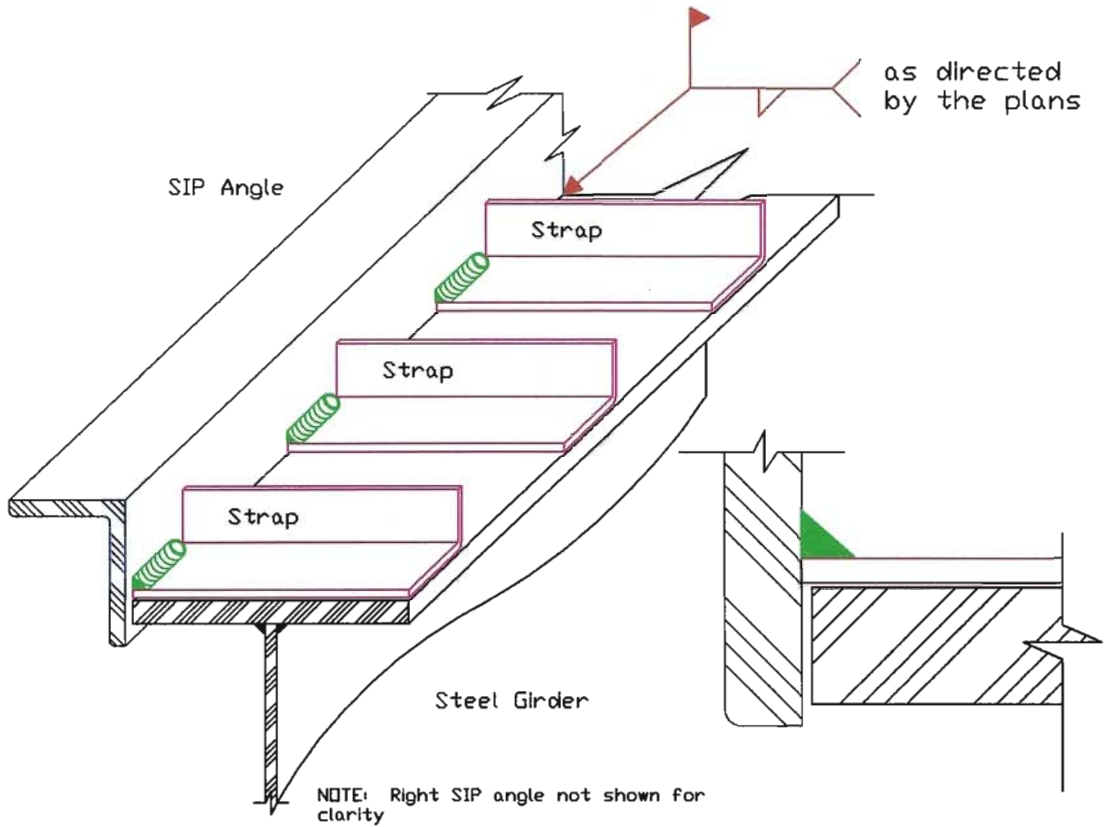
WPS #: 021510015

Authorized By: Steve Walton, Metals Engineer

Revision #: 2

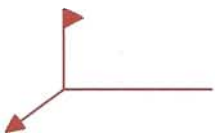
Signature: 

WPS STEEL GIRDER with SIP STRAP 021510015 R2
JOINT DETAIL ATTACHMENT



STEEL GIRDER
W/SIP STRAP DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD SYMBOL



FILLET WELD, ARROW
SIDE

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION PIPE-PILE BOTTOM DRIVING PLATE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.1

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.1, Sections 2 thru 6

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-150 120-200	20-23 21-24	6-9 ipm 6-10 ipm		SEE ATTACHMENT

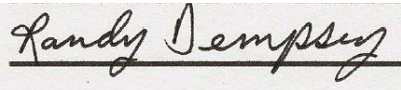
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: PIPE PILE BOTTOM DRIVING PLATE

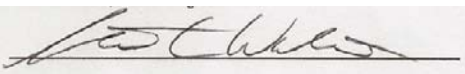
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

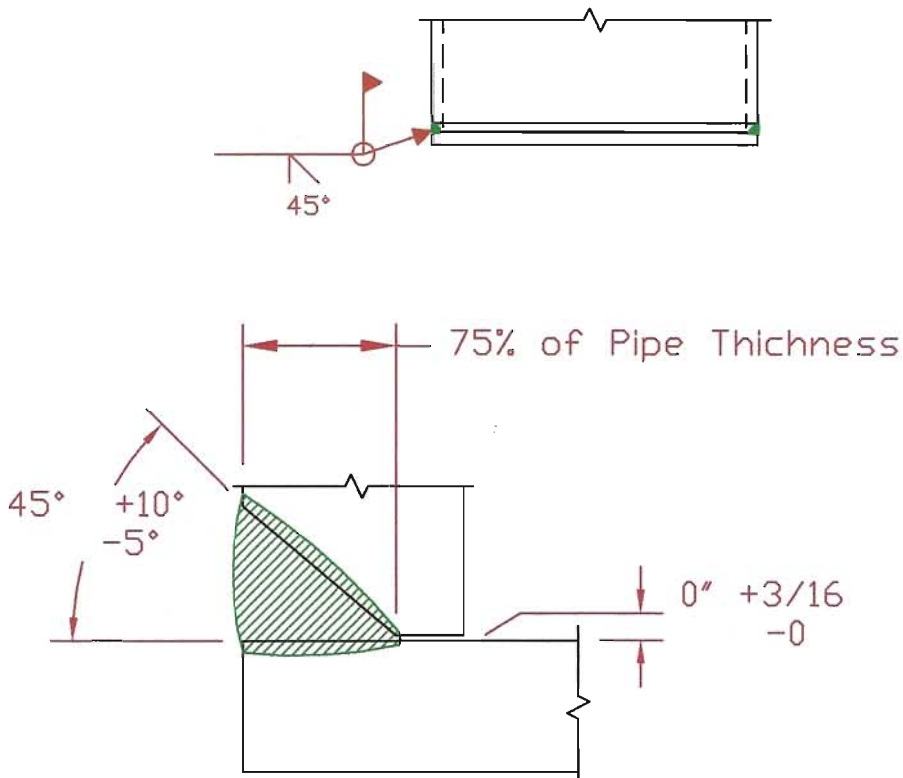
WPS #: 022511016

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

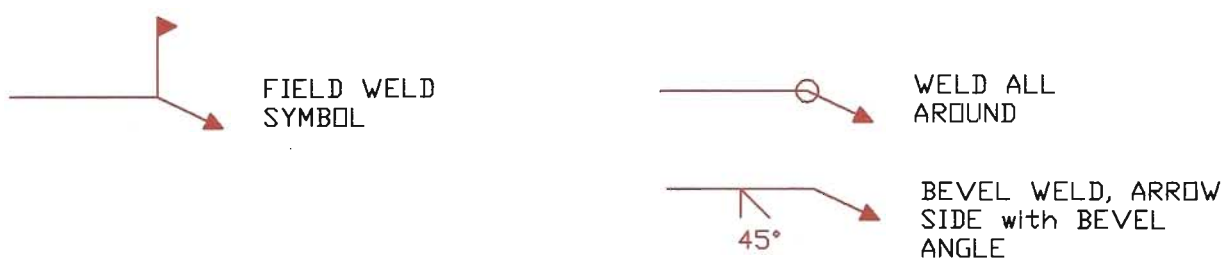
Signature: 

WPS PIPE-PILE BOTTOM DRIVING PLATE
022511016 R1 JOINT DETAIL ATTACHMENT



PIPE PILE BOTTOM DRIVING
PLATE SPLICE DETAILS

Weld Symbol definitions per AWS A2.4:2007



NORTH CAROLINA DEPARTMENT OF TRANSPORTATION STEEL GIRDER POT BEARING WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

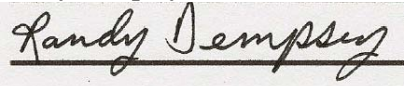
- 1. Bearing Assemblies shall not be lifted by their top plates. Any handling shall support the bearing unit from the underside.**
- 2. Bearings are to be protected from the dust during storage and erection.**
- 3. Remove keeper straps after the bearing has been positioned at its permanent location and prior to erection of the superstructure.**
- 4. When welding the top plate to the girder flange, use temperature indicating crayons or other suitable means to ensure that the bearing does not exceed 250°.**
- 5. Do not permit welding current to pass through the interior parts of the bearing. Arcing may occur which can permanently damage the bearing.**
- 6. Disassembly of the bearing unit is not permitted without written consent from the manufacturer. Unauthorized disassembly could result in bearing failure.**
- 7. The Contractor shall rotate the top plates of the bearing so that the alignment is parallel to the center line of the girder.**

WPS Description: Steel Girder Pot Bearing

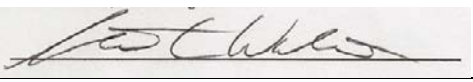
WPS #: 022811017

Revision #: 1

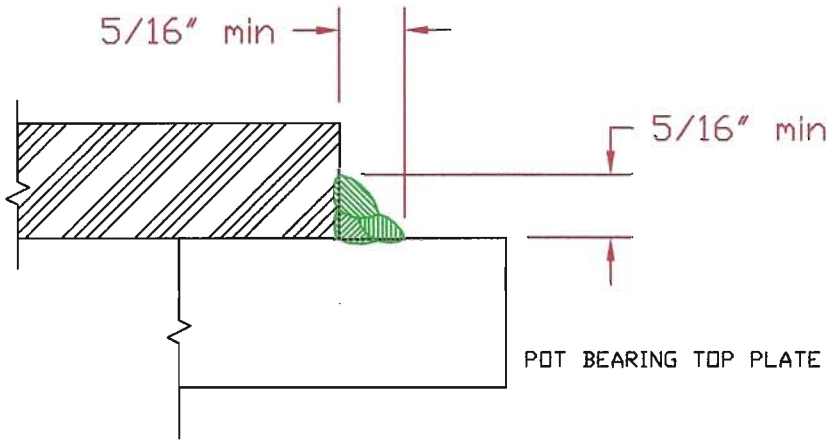
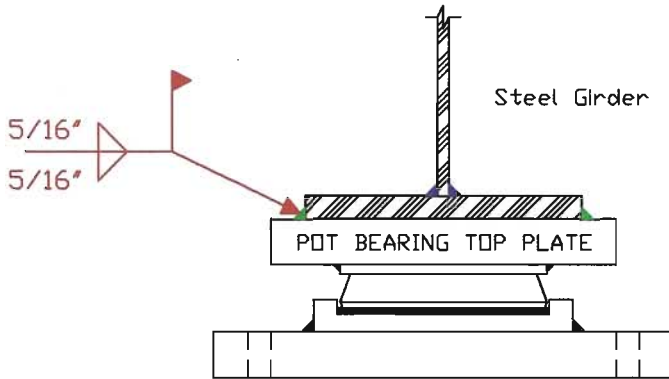
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

Authorized By: Steve Walton, Metals Engineer

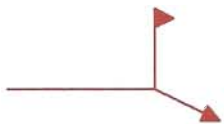
Signature: 

WPS STEEL GIRDER POT BEARING 022811017 R1
JOINT DETAIL ATTACHMENT

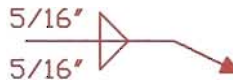


STEEL GIRDER
POT BEARING DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD SYMBOL



FILLET WELD, BOTH
SIDES with WELD SIZE

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION SOLDIER-PILE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: Vertical – up

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8" 5/32"	90-150 120-200	20-23 21-24	6-9 ipm 6-10 ipm		SEE ATTACHMENT

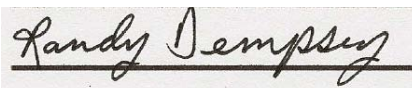
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded prior to fit-up. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description SOLDIER-PILE

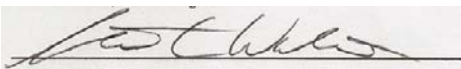
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

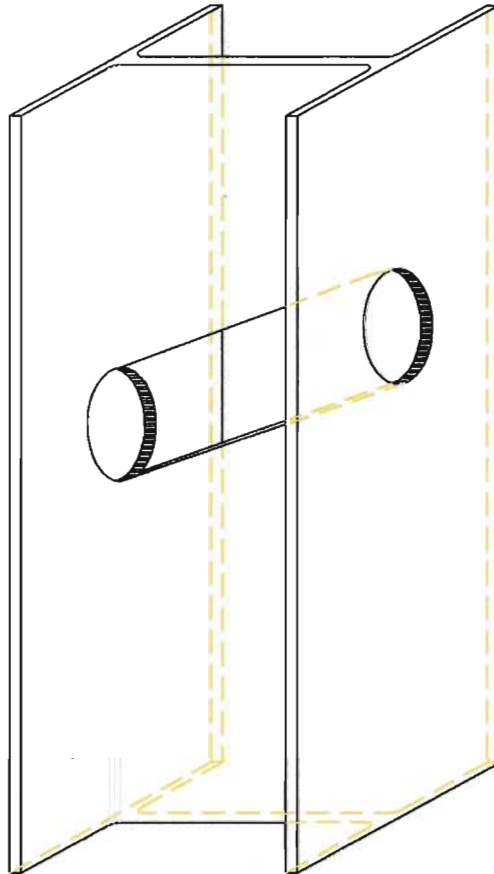
WPS #: 030811018

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

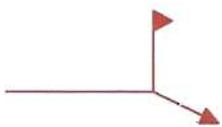
Signature: 

WPS SOLDIER-PILE 030811018 R1 JOINT DETAIL ATTACHMENT 1,
(cut holes in flange and remove web material)



SOLDIER-PILE WEB DETAILS

Weld Symbol definitions per AWS A2.4:2007

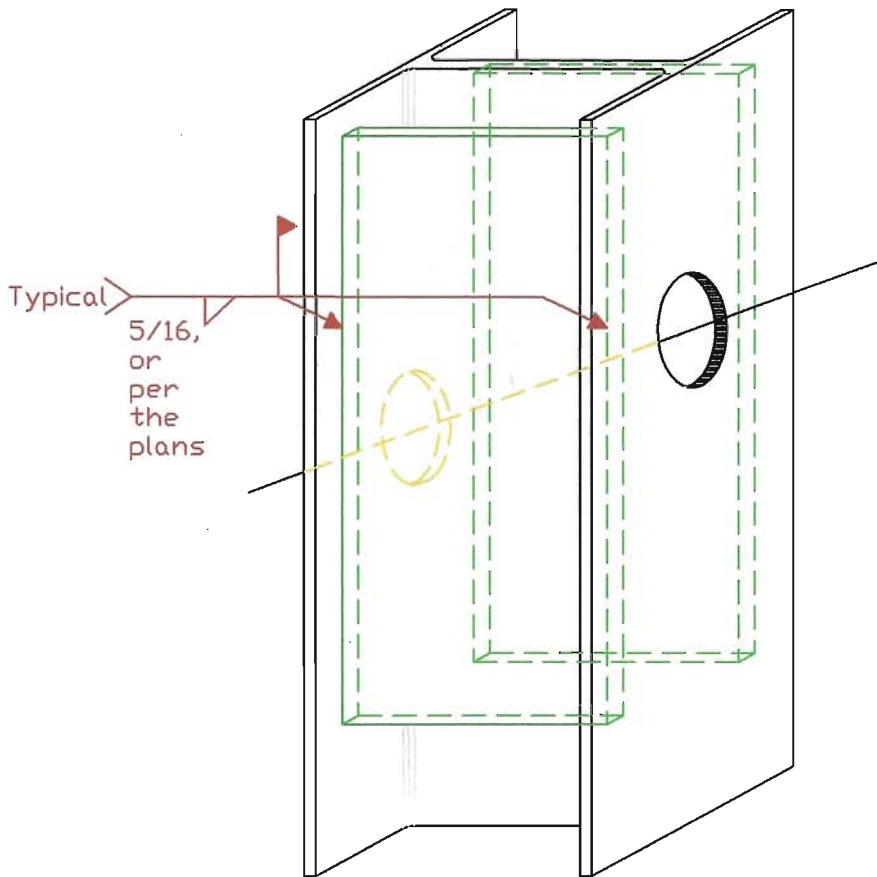


FIELD WELD SYMBOL



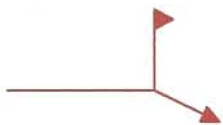
FILLET WELD, ARROW
SIDE with WELD SIZE

WPS SOLDIER-PILE 030811018 R1 JOINT DETAIL ATTACHMENT 2,
(install stiffener plates, near and far side)

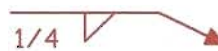


SOLDIER-PILE STIFFENER DETAILS

Weld Symbol definitions per AWS A2.4:2007

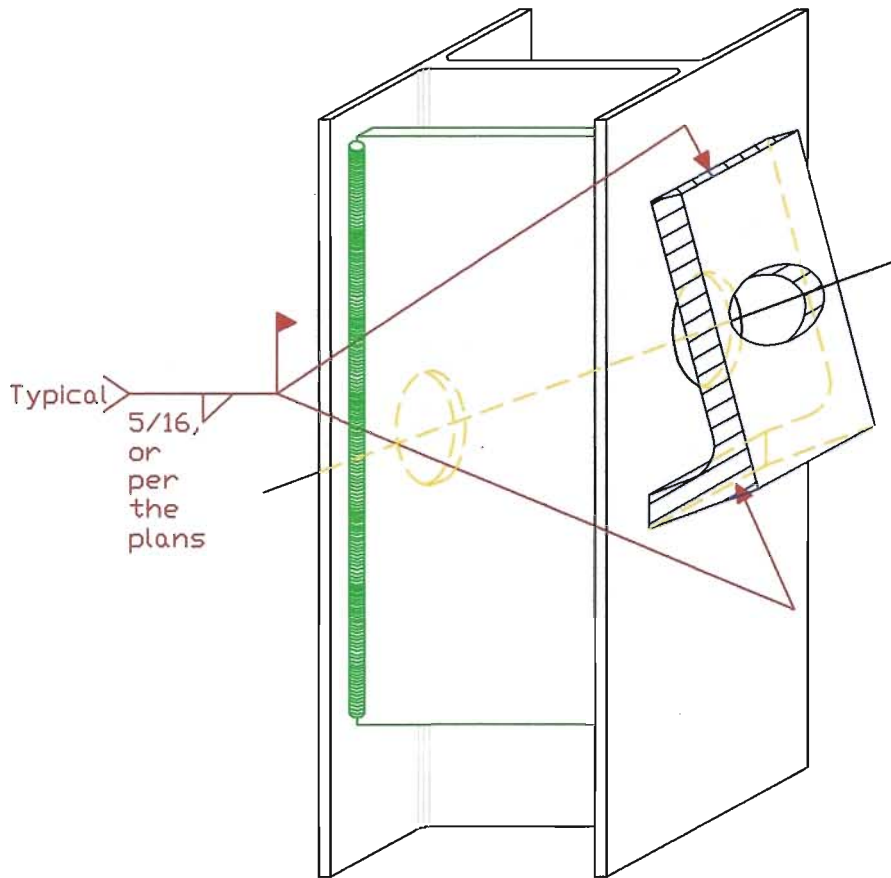


FIELD WELD SYMBOL



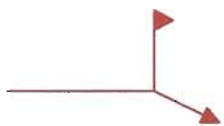
FILLET WELD, ARROW
SIDE with WELD SIZE

WPS SOLDIER-PILE 030811018 R1 JOINT DETAIL ATTACHMENT 3,
(install anchor angle)



SOLDIER-PILE ANCHOR DETAILS

Weld Symbol definitions per AWS A2.4:2007

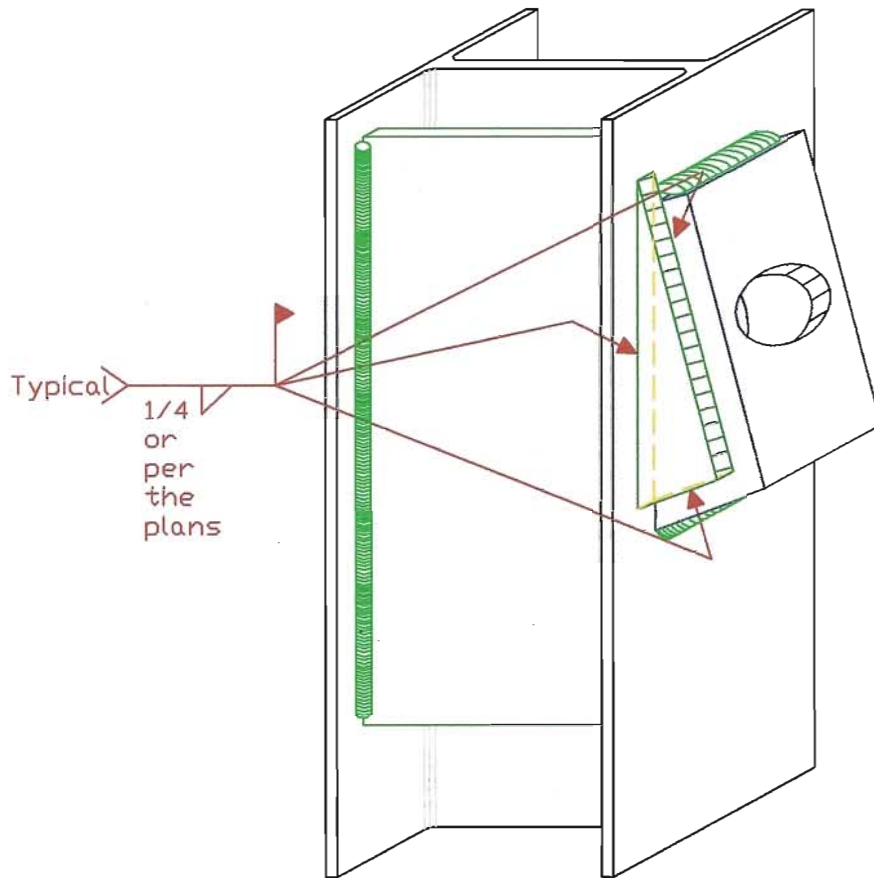


FIELD WELD SYMBOL



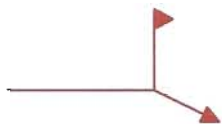
FILLET WELD, ARROW
SIDE with WELD SIZE

WPS SOLDIER-PILE 030811018 R1 JOINT DETAIL ATTACHMENT 4,
(install gusset, near and far side in line with stiffener)

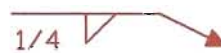


SOLDIER-PILE ANCHOR DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD WELD SYMBOL



FILLET WELD, ARROW
SIDE with WELD SIZE

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NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

SINGLE V-GROOVE WITH BACKING

WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed	Position	Joint Details
		Amperes	Volts			
All	1/8" 5/32" 3/16"	90-150	20-23	6-9 ipm	All Flat, Horizontal	SEE ATTACHMENT
		120-200	21-24	6-10 ipm		
		170-280	21-24	6-11 ipm		

PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

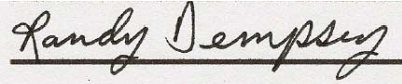
COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

The backing material needs to be in intimate contact with the base metal, but in all cases shall have no more than 1/16" gap (see attachment).

WPS Description: Single V-Groove With Backing

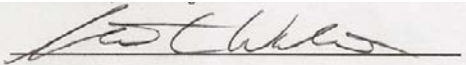
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Signature: 

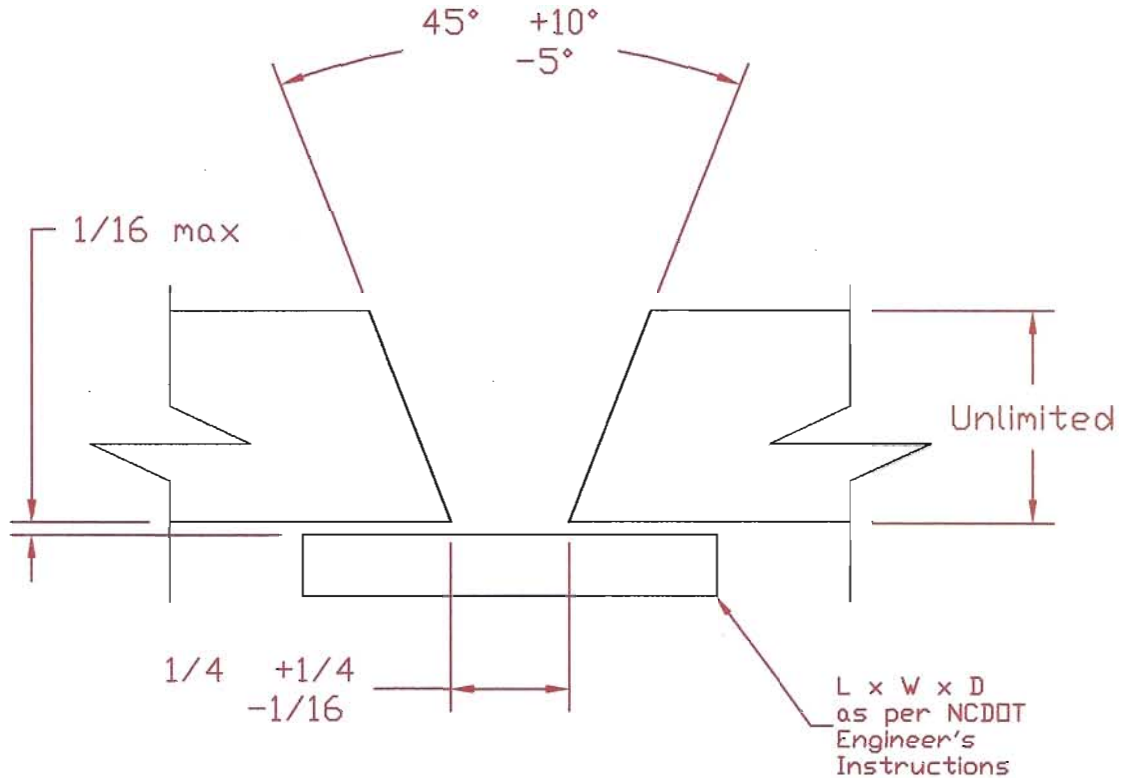
WPS #: 031711021

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

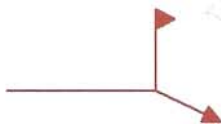
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WPS SINGLE V GROOVE with Backing 031711021 R1
JOINT DETAIL ATTACHMENT

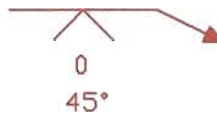


SINGLE V GROOVE with Backing
JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD
WELD
SYMBOL



Single V Groove,
w/Root Opening and
Groove Angle

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

SINGLE V-GROOVE WITH BACK GOUGE

WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: Back Gouge with a grinder to sound metal prior to applying the back weld.

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed	Position	Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm	All Flat, Horizontal	SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

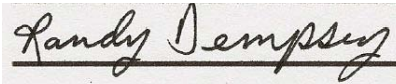
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Single V-Groove With Back Gouge

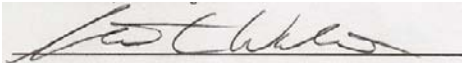
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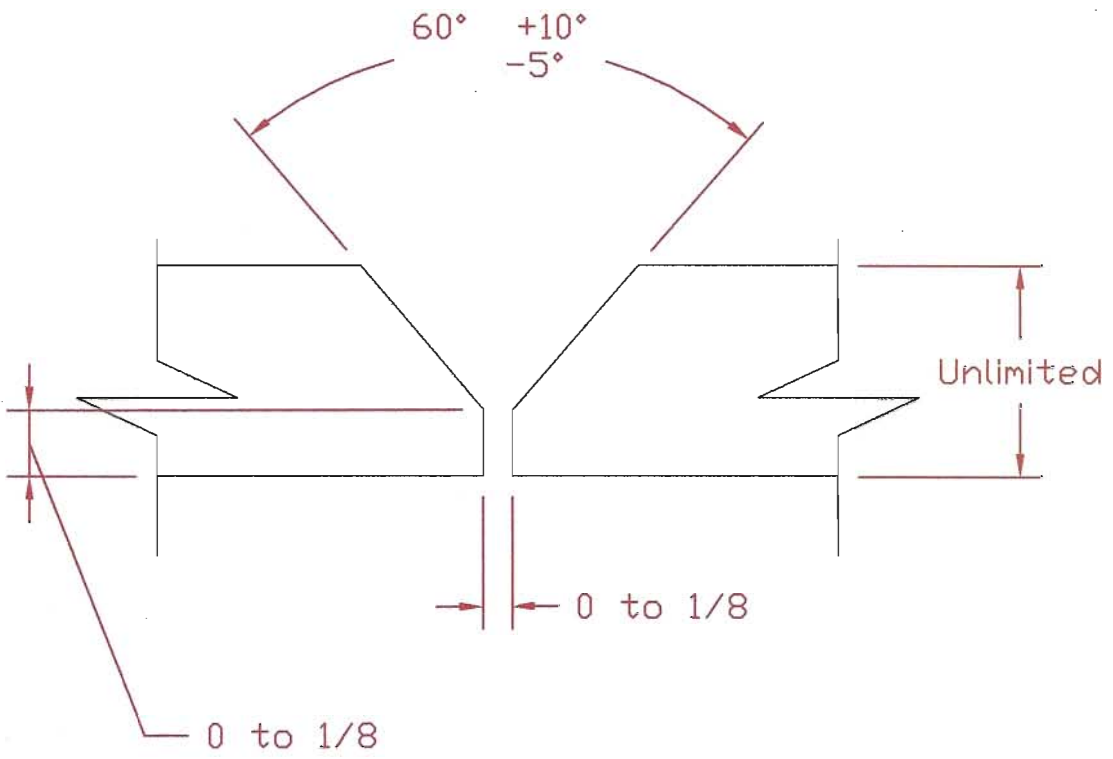
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Authorized By: Steve Walton, Metals Engineer

Revision #: 1

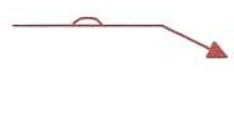
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WPS SINGLE V GROOVE with Back Gouge 031711022 R1
 JOINT DETAIL ATTACHMENT

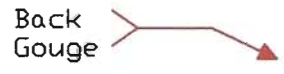


SINGLE V GROOVE with Back Gouge
JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007

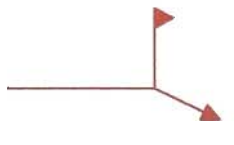


BACK
 WELD,
 OTHER
 SIDE

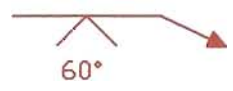


Back
 Gouge

Back Gouge
 Required before
 welding side two



FIELD
 WELD
 SYMBOL



Single V Groove,
 w/ Groove Angle

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION DOUBLE BEVEL GROOVE WITH BACK GOUGE WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Horizontal

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: Back Gouge with a grinder to sound metal prior to applying weld to the second side.

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT
All	5/32"	120-200	21-24	6-10 ipm		

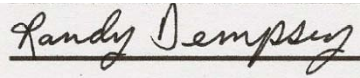
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Double Bevel Groove With Back Gouge

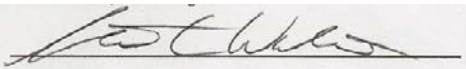
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Signature: 

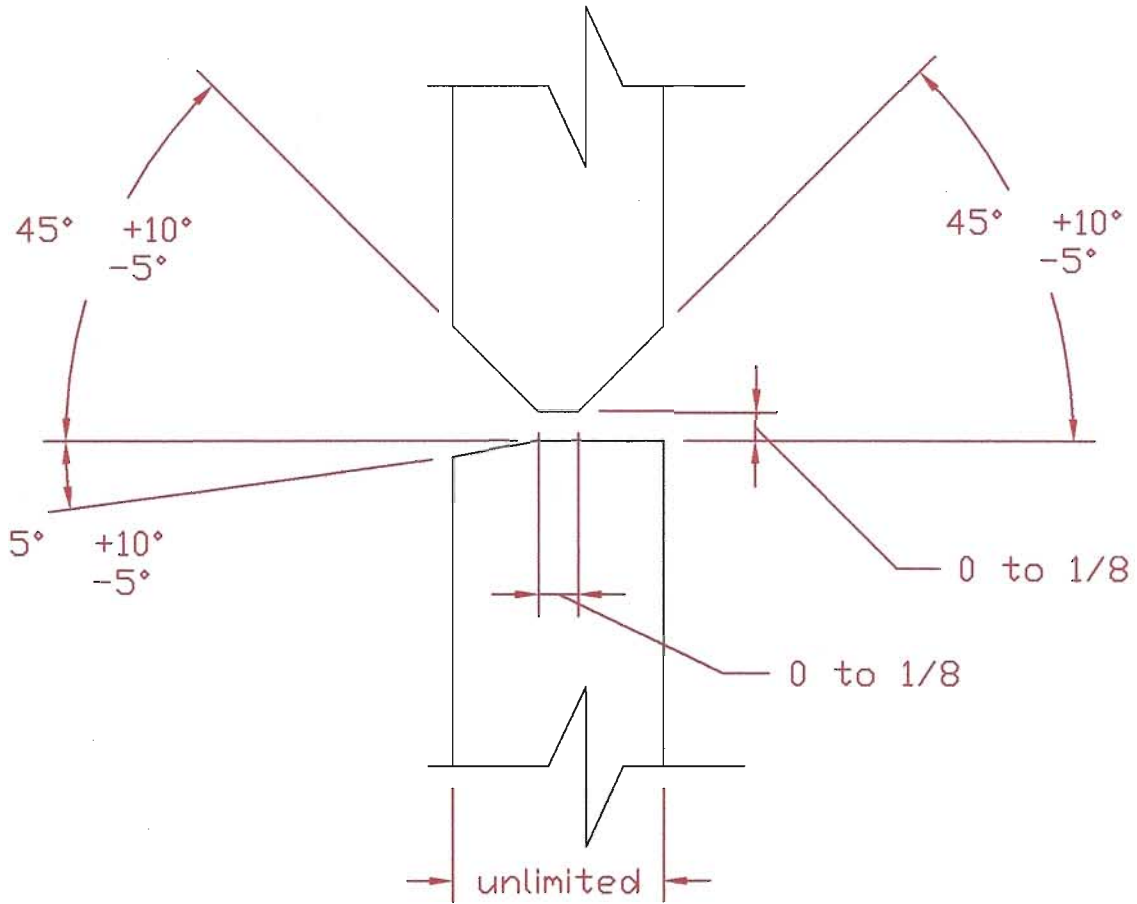
WPS #: 031711023

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

Signature: 

WPS DOUBLE BEVEL GROOVE with Back Gouge 031711023 R1
 JOINT DETAIL ATTACHMENT



DOUBLE BEVEL GROOVE with Back Gouge
JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007

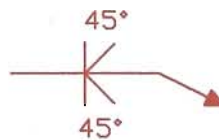
Back Gouge



Back Gouge
 Required before
 welding side two



FIELD
 WELD
 SYMBOL



Double BEVEL Groove,
 w/ Groove Angle

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

DOUBLE V GROOVE WITH BACK GOUGE

WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: Back Gouge with a grinder to sound metal prior to applying weld to the second side.

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed	Position	Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm	All	SEE ATTACHMENT
All	5/32"	120-200	21-24	6-10 ipm	All	

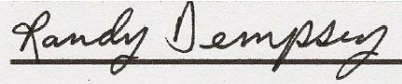
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Double V Groove With Back Gouge

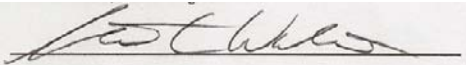
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Signature: 

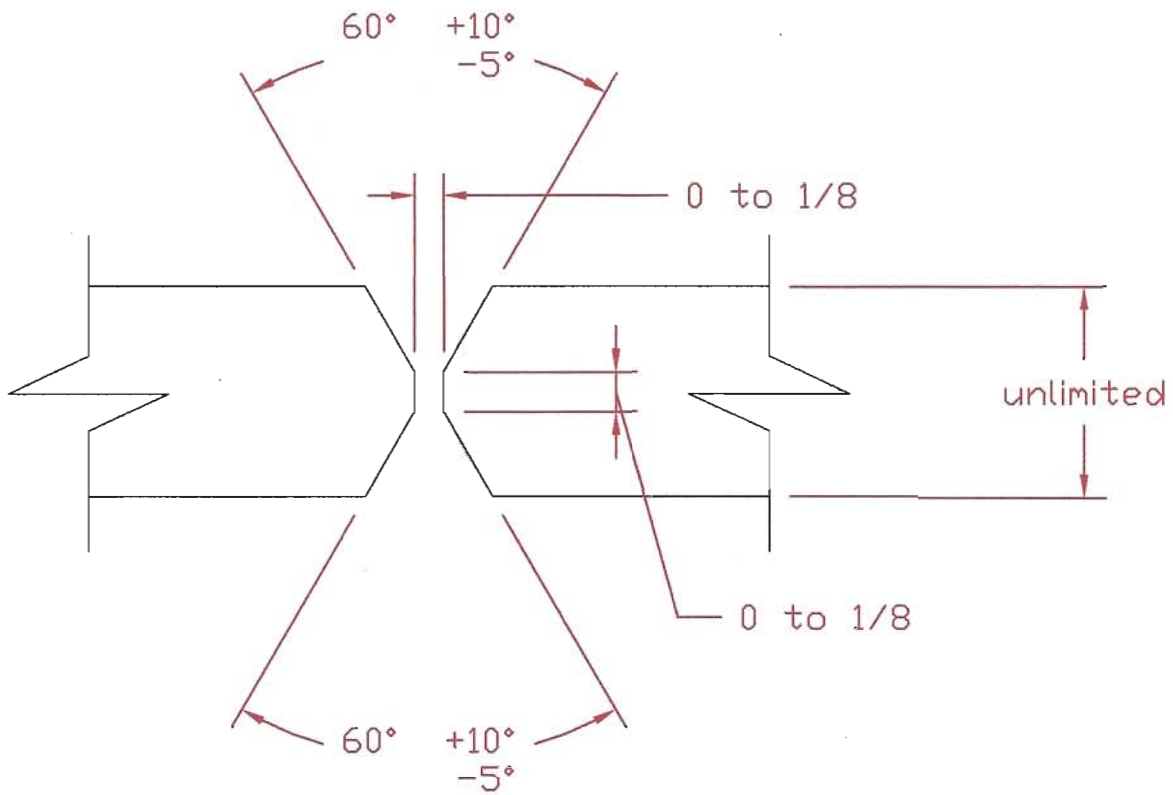
WPS #: 031711025

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

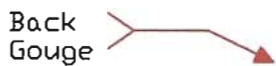
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WPS DOUBLE V GROOVE with Back Gouge 031711025 R1
JOINT DETAIL ATTACHMENT

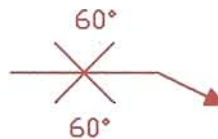
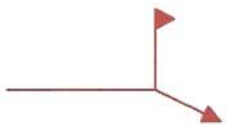


DOUBLE V GROOVE with Back Gouge
JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



Back Gouge
Required before
welding side two



Double V Groove,
w/ Groove Angle

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION FILLET WELD WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed	Position	Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm	All Flat, Horizontal	SEE ATTACHMENT
	5/32"	120-200	21-24	5-10 ipm		
	3/16"	170-280	21-24	4-11 ipm		

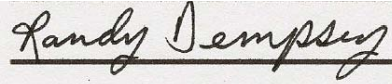
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description Fillet Weld

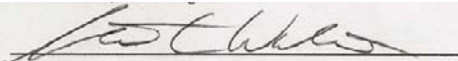
Written By: Randy Dempsey, CWI/CWE, TT IV

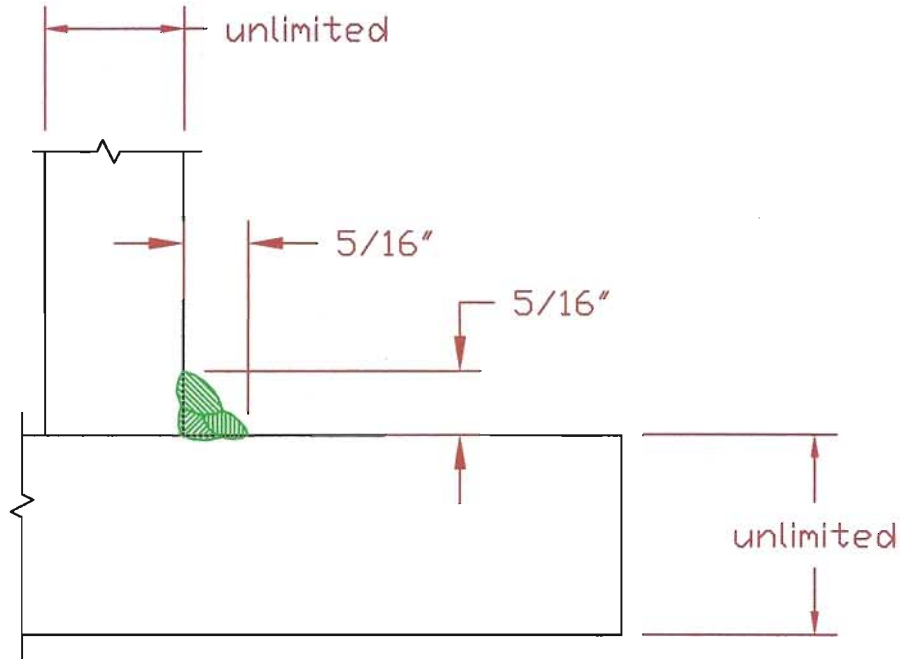
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WPS #: 032811027

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

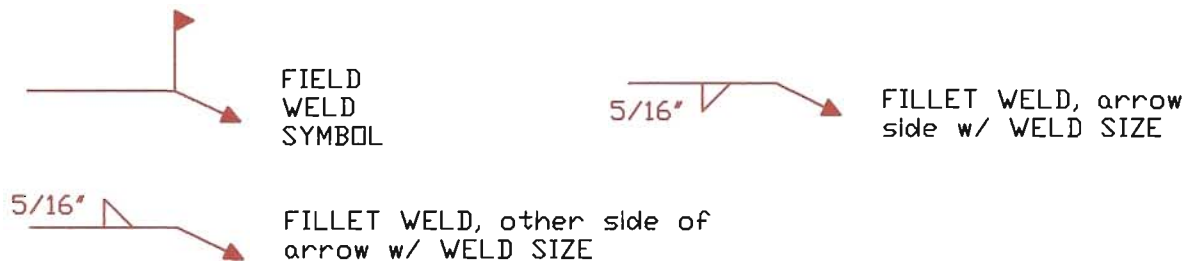
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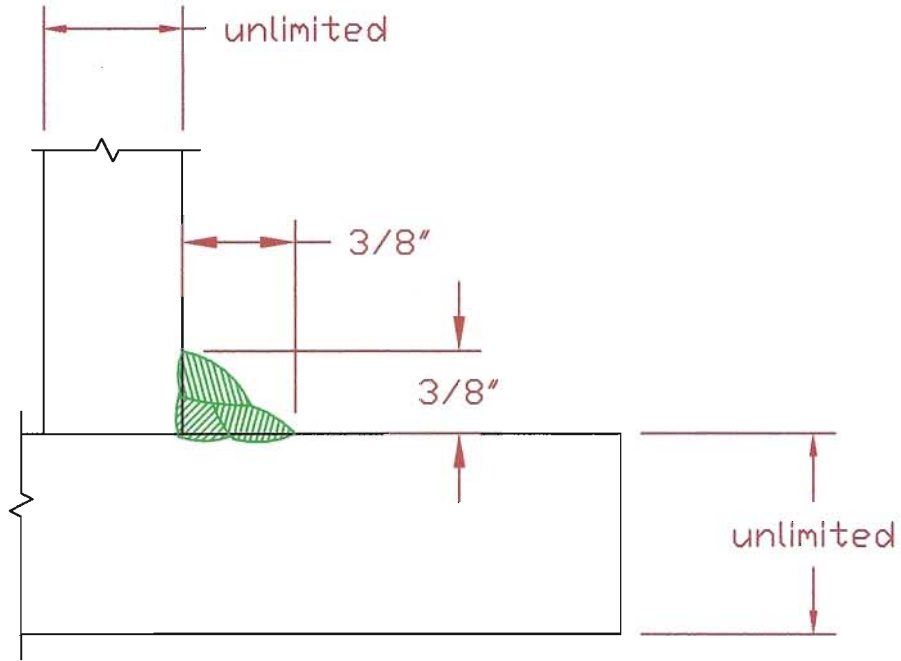


Typical weld size for 1/8" 7018 Electrode, Horizontal 3 passes

STANDARD FILLET WELD DETAILS

Weld Symbol definitions per AWS A2.4:2007

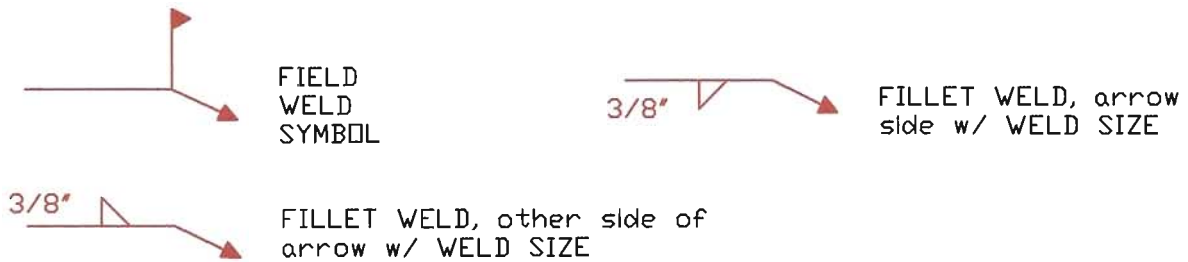


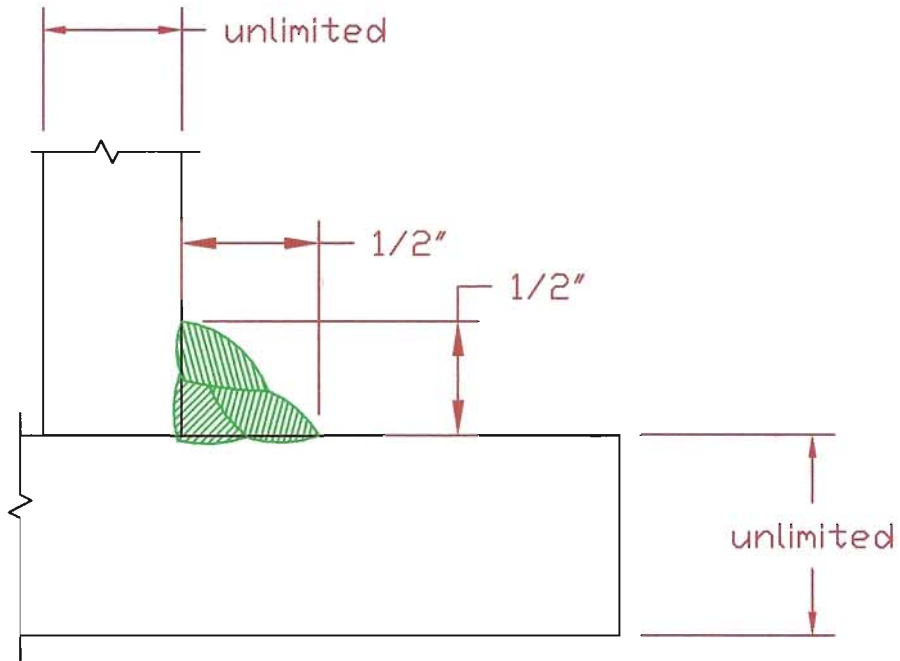


Typical weld size for 5/32" 7018 Electrode, Horizontal 3 passes

STANDARD FILLET WELD DETAILS

Weld Symbol definitions per AWS A2.4:2007

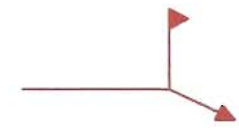




Typical weld size for $3/16''$ 7018 Electrode, Horizontal 3 passes

STANDARD FILLET WELD DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD
WELD
SYMBOL



FILLET WELD, arrow
side w/ WELD SIZE



FILLET WELD, other side of
arrow w/ WELD SIZE

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

ARMOR ANGLE FIELD SPLICE

WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed		Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm		SEE ATTACHMENT

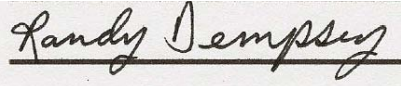
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Armor Angle Field Splice

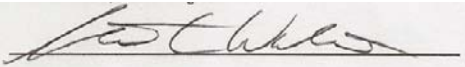
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

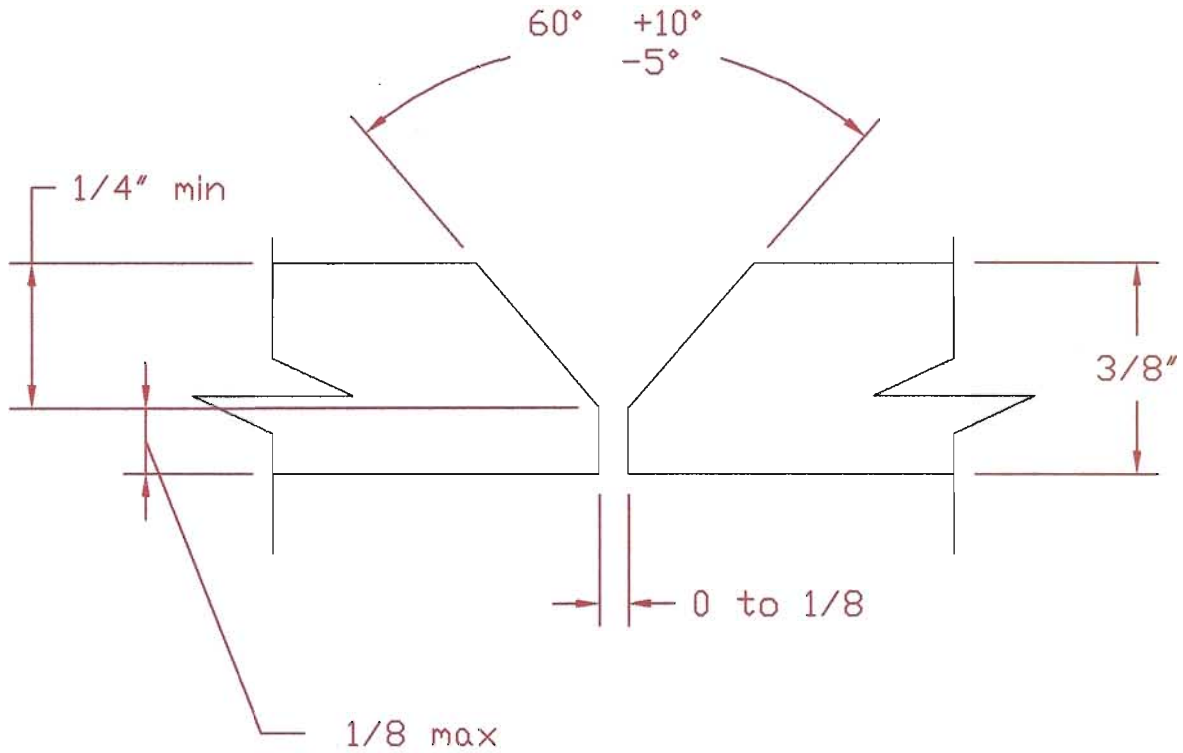
WPS #: 032811028

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

Signature: 

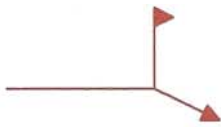
WPS ARMOR ANGLE Field Splice 032811028 R1
JOINT DETAIL ATTACHMENT



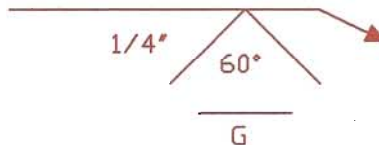
Bevel Horizontal Leg of Angle Only

ARMOR ANGLE Field Splice JOINT DETAILS

Weld Symbol definitions per AWS A2.4:2007



FIELD
WELD
SYMBOL



Single V Groove,
w/ Depth of Groove,
Groove Angle and Grind
Flush Symbol

NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

SINGLE U-GROOVE WITH BACK GOUGE

WELDING PROCEDURE SPECIFICATION (WPS) AWS D1.5

Specifications & Codes: NCDOT Standard Specifications/AASHTO/AWS D1.5, Section 2, 5 and 12

Material Specifications: ASTM A-36, A572, (A709-36, 50), (M270-GR250, 345) Unlimited Thickness

Welding Process: SMAW Manual or Semi- Automatic or Automatic: Manual

Filler Metal Specification: AWS A5.1 Classification: E-7018

Manufacturer: NCDOT Approved Electrodes Single or Multiple Pass both Position of Weld Flat, Horizontal, Vertical, Overhead

Welding Current: DC Polarity: Positive Progression: N/A

Root Treatment: N/A

Preheat Temp: 100° minimum Interpass: 450° maximum Post Heat: N/A

Pass Num.	Electrode Size	Welding Current		Travel Speed	Position	Joint Details
		Amperes	Volts			
All	1/8"	90-150	20-23	6-9 ipm	All Flat, Horizontal	SEE ATTACHMENT
	5/32"	120-200	21-24	6-10 ipm		
	3/16"	170-280	21-24	6-11 ipm		

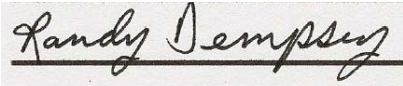
PREHEAT	
Thickness	Min. Temp.
Up to 3/4"	100°
Over 3/4" to 1 1/2"	100°
Over 1 1/2" to 2 1/2"	150°
Over 2 1/2"	225°

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded. If the Air Arc process is used to develop the groove, ensure that all carbon deposits have been removed from the area to be welded. Remove all slag, spatter and weld discontinuities between passes. Clean the completed weld of all debris, slag and spatter.

WPS Description: Single U-Groove with Back Gouge

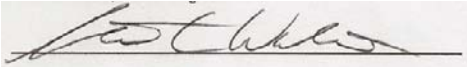
Written By: Randy Dempsey, CWI/CWE, TT IV

Signature: 

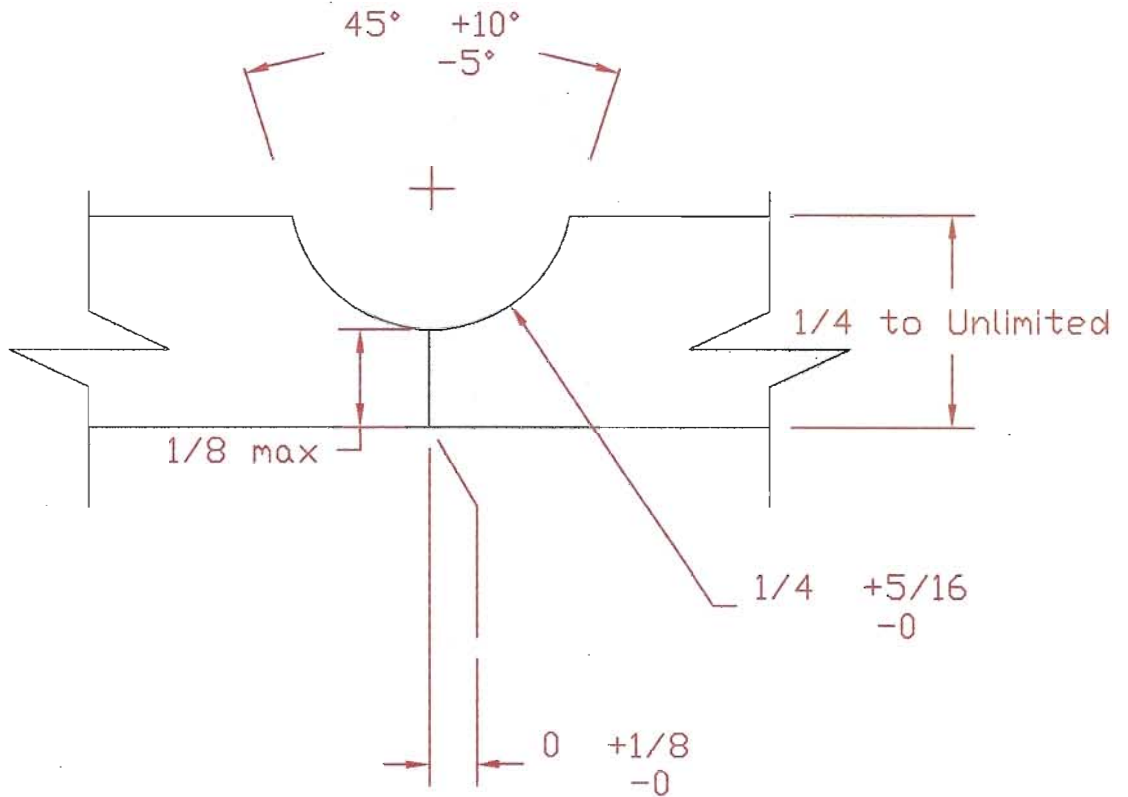
WPS #: 050511029

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

Signature: 

WPS SINGLE U GROOVE BACKGOUGE 050511029 R1
 JOINT DETAIL ATTACHMENT 1



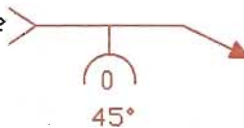
SINGLE U GROOVE BACKGOUGE
JOINT DETAIL

Weld Symbol definitions per AWS A2.4:2007



FIELD
 WELD
 SYMBOL

Backgouge



Single U Groove, w/Root
 Opening and Groove
 Angle

Appendix A WELDING TERMS AND DEFINITIONS

A

acceptable weld

A weld that meets the applicable requirements.

aligned porosity

A localized array of porosity oriented in a line.

arc blow

The deflection of an arc from its normal path due to magnetic forces.

arc strike

A discontinuity resulting from an arc, consisting of any localized re-melted metal, heat-affected metal, or change in the surface profile of any metal object.

B

backgouging

The removal of weld metal and base metal from the weld root side of a welded joint to facilitate complete fusion and complete joint penetration upon subsequent welding from that side.

backing

A material placed against the back side of the joint adjacent to the joint root to support and shield molten weld metal.

backing ring

Backing in the form of a ring, generally used in pipe welding (also referred to as a chill ring).

backing weld

Backing in the form of a weld (applied prior to the single groove weld which then requires backgouging to be performed from the groove side).

Not permitted unless used with an approved WPS.

back weld

A weld made at the back of a single groove weld.

base material

The material that is welded, brazed, soldered or cut (also referred to as ***base metal***).

bevel angle

The angle between the bevel of a joint member and a plane perpendicular to the surface of the member.

bevel face

The prepared surface of a bevel edge shape.

Appendix A WELDING TERMS AND DEFINITIONS

buildup

A surfacing variation in which surfacing material is deposited to achieve the required dimensions. See also buttering.

buttering

A surfacing variation that deposits surfacing metal [weld metal] on one or more surfaces to provide compatible material for the subsequent completion of the weld.

butt joint

A joint between two members aligned approximately in the same plane.

C

carbon arc cutting

An arc cutting process that uses a carbon electrode.

carbon electrode

A non-filler metal electrode used in arc welding and cutting, consisting of a carbon or graphic rod, which may be coated with copper or other materials.

caulking

Plastic deformation of weld and adjacent base metal surfaces by mechanical means to seal or obscure discontinuities.

chain intermittent weld

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.

chill ring

A nonstandard term when used for backing ring.

cluster porosity

A localized array of porosity having a random geometric distribution.

cold lap

A nonstandard term when used for incomplete fusion or overlap.

complete joint penetration (CJP)

A groove weld condition in which weld metal extends through the joint thickness.

continuous weld

A weld that extends continuously from one end of a joint to the other. Where the joint is essentially circular, it extends completely around the joint.

Appendix A WELDING TERMS AND DEFINITIONS

convexity

The maximum distance from the face of a convex fillet weld perpendicular to a line joining the weld toes.

crater

A depression in the weld face at the termination of a weld bead.

D

defect

A discontinuity or discontinuities that by nature or accumulated effect render a part or product unable to meet applicable acceptance standards or specifications. The term designates rejectability.

deposited metal

Filler metal that has been added during welding.

discontinuity

An interruption of the typical structure of a material, such as a lack of homogeneity in its mechanical, metallurgical, or physical characteristics. A discontinuity is not necessarily a defect.

E

effective throat

The minimum distance from the fillet weld face, minus any convexity, and the weld root.

electrode holder

A device used for mechanically holding and conducting current to an electrode during welding or cutting.

elongated porosity

A form of porosity having a length greater than its width that lies approximately parallel to the weld axis.

F

faying surface

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.

field weld

A weld made at a location other than a shop or the place of the initial construction.

Appendix A WELDING TERMS AND DEFINITIONS

filler material* or *filler metal

The material or metal to be added in making a weld.

fillet weld

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.

fillet weld leg

The distance from the root to the toe of the fillet weld.

fillet weld size

For equal leg fillet welds, the leg lengths of the largest isosceles right triangle that can be inscribed within the fillet weld cross section. For unequal leg fillet welds, the leg lengths of the largest right triangle that can be inscribed within the fillet weld cross section.

flux

A material used to hinder or prevent the formation of oxides and other undesirable substances in molten metal and on solid metal surfaces.

fusion

The melting together of filler metal and base metal, or of base metal only, to produce a weld.

G

groove angle

The included angle between the groove faces of a weld groove.

groove face

Any surface in a weld groove prior to welding.

groove weld

A weld in a weld groove on a work piece surface, between work piece edges and surrounding surfaces.

H

heat affected zone

The portion of base metal whose mechanical properties or microstructure have been altered by the heat of the welding.

hermetically sealed container

A container that has been closed in a manner that provides a non-permeable barrier to the passage of air or gas in either direction.

Appendix A WELDING TERMS AND DEFINITIONS

I

inclusion

Entrapped foreign solid material, such as slag, flux, tungsten, or oxide.

incomplete fusion

A weld discontinuity in which fusion did not occur between weld metal and fusion faces or adjoining weld beads.

incomplete joint penetration

A joint root condition in a groove weld in which weld metal does not extend through the joint thickness.

interpass temperature

In a multi pass weld, the temperature of the weld area between weld passes.

J

joint design

The shape, dimensions, and configuration of the joint.

joint geometry

The shape, dimensions and configuration of a joint prior to welding.

joint penetration

The distance the weld metal extends from the weld face into a joint, exclusive of weld reinforcement.

K

kerf

The gap produced by a cutting process.

L

lamination

A type of discontinuity with separation or weakness generally aligned parallel to the worked surface of a metal.

longitudinal crack

A crack with its major axis orientation approximately parallel to the weld axis.

Appendix A WELDING TERMS AND DEFINITIONS

M

multi pass weld

A fusion weld produced by more than one progression of the arc along the joint.

O

overlap

The protrusion of weld metal beyond the weld toe.

P

peening

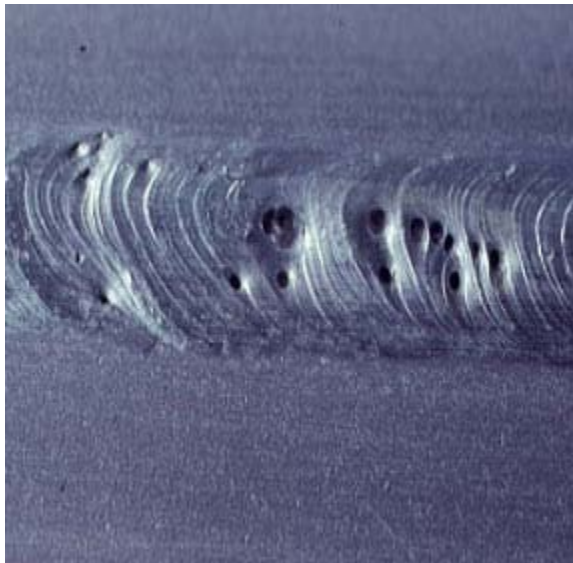
The mechanical working of metals using impact blows.

pipng porosity

A form of porosity having a length greater than its width that lies approximately perpendicular to the weld face.

porosity

Cavity type discontinuities formed by gas entrapment during solidification or in a thermal spray deposit.



preheat

The heat applied to the base metal or substrate to attain and maintain preheat temperature.

Appendix A WELDING TERMS AND DEFINITIONS

R

residual stress

Stress present in a joint member or material that is free of external forces or thermal gradients.

root face

That portion of the groove face within the joint root.

root opening

A separation at the joint root between the work pieces.

runoff weld tab

Additional material that extends beyond the end of the joint, on which the weld is started and terminated.

S

shielded metal arc welding (SMAW)

An arc welding process with an arc between a covered electrode and the weld pool.

slag inclusion

A discontinuity consisting of slag entrapped in weld metal or at the weld interface.

slugging

The unauthorized addition of metal, such as a length of rod, to a joint before welding or between passes, often resulting in a weld with incomplete fusion.

surface preparation

The operations necessary to produce a desired or specified surface condition.

T

theoretical throat

The distance from the beginning of the joint root perpendicular to the hypotenuse of the largest right triangle that can be inscribed within the cross section of the fillet weld.

transverse crack

A crack with its major axis oriented approximately perpendicular to the weld axis.

Appendix A WELDING TERMS AND DEFINITIONS

U

undercut

A groove melted into the base metal adjacent to the weld toe or weld root and left unfilled by the weld metal.

underfill

A groove weld condition in which the weld face or root surface is below the adjacent surface of the base metal.

W

weld

A localized coalescence of metals or nonmetals produced either by heating the materials to the welding temperature, with or without the application of pressure, or by the application of pressure alone and with or without the use of filler material.

weld face

The exposed surface of a weld on the side from which welding was done.

weld interface

The interface between weld metal and base metal in a fusion weld.

weld reinforcement

Weld metal in excess of the quantity required to fill a weld groove.

weld root

The points, shown in cross section, at which the weld metal intersects the base metal and extends furthest into the weld joint.

welding

A joining process that produces coalescence of materials by heating them to the welding temperature, with or without the application of pressure, or by the application of pressure alone and with or without the use of filler material.

weldment

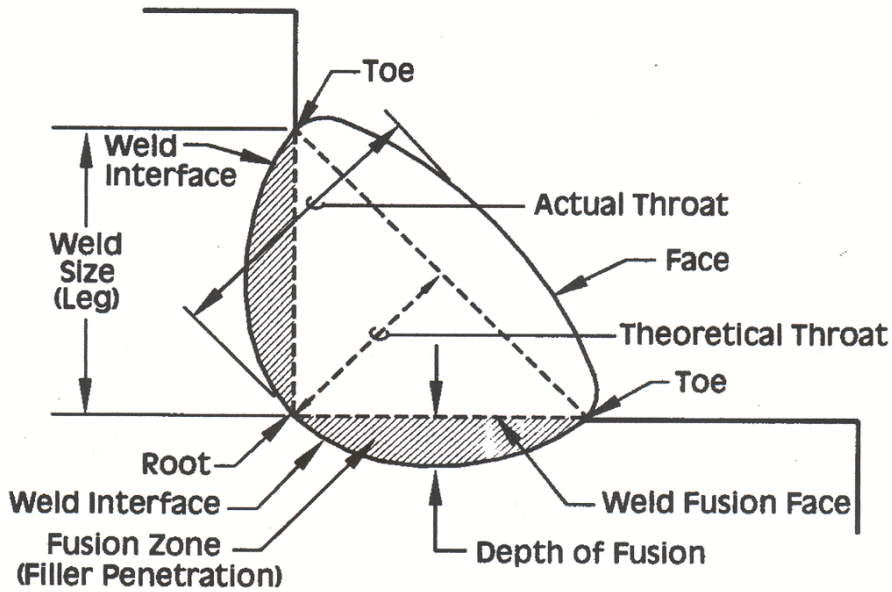
An assembly whose component parts are joined by welding.

weld toe

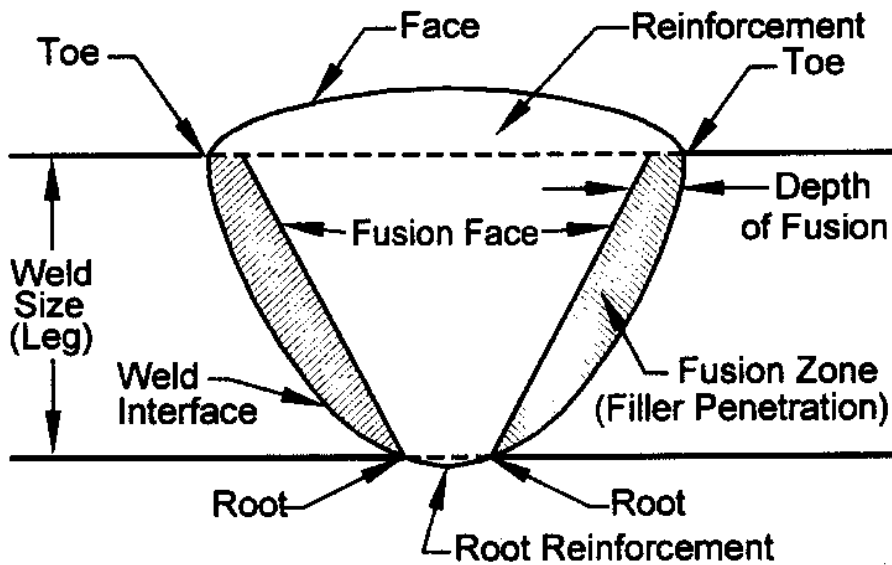
The junction of the weld face and the base metal.

Appendix A WELDING TERMS AND DEFINITIONS

Parts of a Fillet Weld



Parts of a Groove Weld



Appendix A WELDING TERMS AND DEFINITIONS

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Standard Symbols for Welding, Brazing, and Nondestructive Examination

1. Scope

This standard presents a system for indicating welding, brazing, and nondestructive examination requirements. The system includes provisions for the graphical representation of welds, brazes, and nondestructive examination methods with conventions for specifying, at a minimum, the location and extent of their application. Optional elements and supplementary symbols provide a means for specifying additional requirements.

The figures included with the text are intended to show how the correct format and applications of symbols may be used to convey welding, brazing, and nondestructive examination information. They are not intended to represent recommended welding, brazing, nondestructive examination, or design practice.

The section addressing brazing uses the same symbols that are used for welding. The section on nondestructive examination symbols establishes the symbols to be used on drawings to specify nondestructive examination for determining the suitability of components. The nondestructive examination symbols included in this standard represent nondestructive examination methods as discussed in the latest edition of the AWS publication AWS B1.10, *Guide for the Nondestructive Examination of Welds*. Definitions and the details for the use of the various nondestructive examination methods are found in AWS B1.10.

For illustrative purposes, this standard makes use of both U.S. Customary and the International System of Units (SI). Examples featuring each system appear throughout the document.

Safety and health issues and concerns are beyond the scope of this standard, and therefore are not fully addressed herein. Safety and health information is available from other sources, including, but not limited to, ANSI Z49.1, *Safety in Welding, Cutting, and Allied Processes*, and applicable federal and state regulations.

The limitations included in specifications and codes are also beyond the scope of this standard.

2. Normative References

The following standards contain provisions which, through reference in this text, constitute provisions of this AWS standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this AWS standard are encouraged to investigate the possibility of applying the most recent editions of the documents shown below. For undated references, the latest edition of the standard referred to applies.

The following American Welding Society¹ standards are used in the mandatory sections of this document:

- (1) AWS A3.0:2001, *Standard Welding Terms and Definitions*;
- (2) AWS A5.30/A5.30M, *Specification for Consumable Inserts*; and
- (3) AWS B1.10, *Guide for the Nondestructive Examination of Welds*.

3. Basic Welding Symbols

3.1 Distinction between Weld Symbol and Welding Symbol. This standard makes a distinction between the terms *weld symbol* and *welding symbol*. The weld symbol indicates the type of weld and, when used, is a part of the welding symbol.

3.2 Basis of Reference. In the present system, the joint is the basis of reference. The *arrow side* is the side of the joint to which the arrow of the symbol points. The *other side* is the side of the joint opposite the arrow side.

3.3 Weld Symbols. Weld symbols shall be as shown in Figure 1. The symbols shall be drawn in contact with the reference line.

¹ AWS standards are published by the American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

3.4 Supplementary Welding Symbols. Supplementary symbols to be used in connection with welding symbols shall be as shown in Figure 2.

3.5 Welding Symbols. A welding symbol may consist of several elements (see Figure 3). Only the reference line and the arrow are required elements. Additional elements may be included to convey specific welding information. Alternatively, welding information may be conveyed by other means such as by drawing notes or details, specifications, standards, codes, or other drawings, which eliminates the need to include the corresponding elements in the welding symbol.

The tail of the symbol is used for designating the welding, brazing, and cutting process as well as the welding or brazing specifications, procedures, or the supplementary information to be used in making the weld or braze. The process; identification of the filler metal that is to be used; whether peening, backgouging, or other operations

are required; and other pertinent data should be known. The notation to be placed in the tail of the symbol indicating these data is usually established by the user.

All elements, when used, shall have specific locations within the welding symbol as shown in Figure 3. Mandatory requirements regarding each element in a welding symbol refer to the location of the element and should not be interpreted as a necessity to include the element in every welding symbol.

3.6 Placement of the Welding Symbol. The arrow of the welding symbol shall point to a line, location, or area that conclusively identifies the joint, location, or area to be welded.

3.7 Illustrations. The examples given, including the dimensions, are illustrative only and are intended to demonstrate the proper application of drafting practices. They are not intended to represent design practices or to replace code or specification requirements.

GROOVE							
SQUARE	SCARF	V	BEVEL	U	J	FLARE-V	FLARE-BEVEL

FILLET	PLUG	SLOT	STUD	SPOT OR PROJECTION	SEAM	BACK OR BACKING	SURFACING	EDGE

NOTE: The reference line is shown as a dashed line for illustrative purposes.

Figure 1—Weld Symbols

WELD ALL AROUND	FIELD WELD	MELT-THROUGH	CONSUMABLE INSERT (SQUARE)	BACKING (RECTANGLE)	SPACER (RECTANGLE)	CONTOUR		
						FLUSH OR FLAT	CONVEX	CONCAVE

Figure 2—Supplementary Symbols

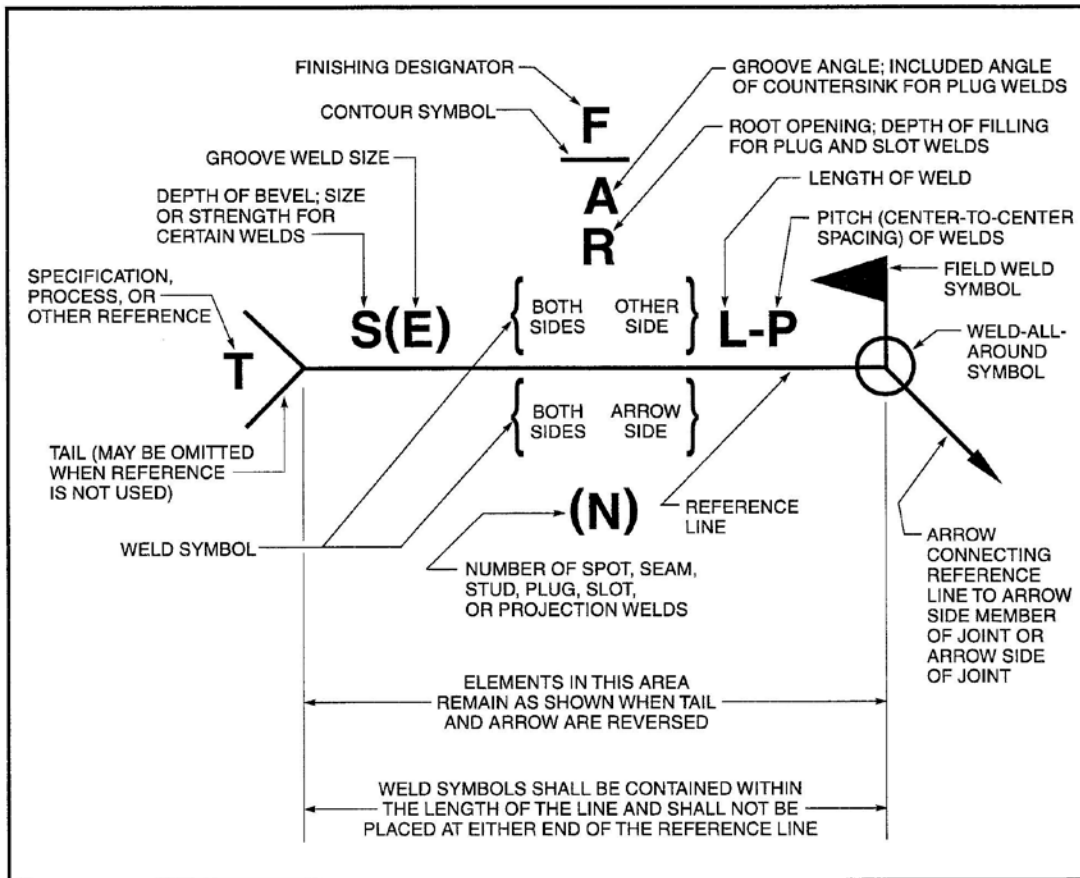


Figure 3—Standard Location of the Elements of a Welding Symbol

4. Joint Types

The basic welding joint types—butt, corner, T-, lap, and edge—are shown in Figure 4. Joint type designators are shown in Annex A, Table A.1.

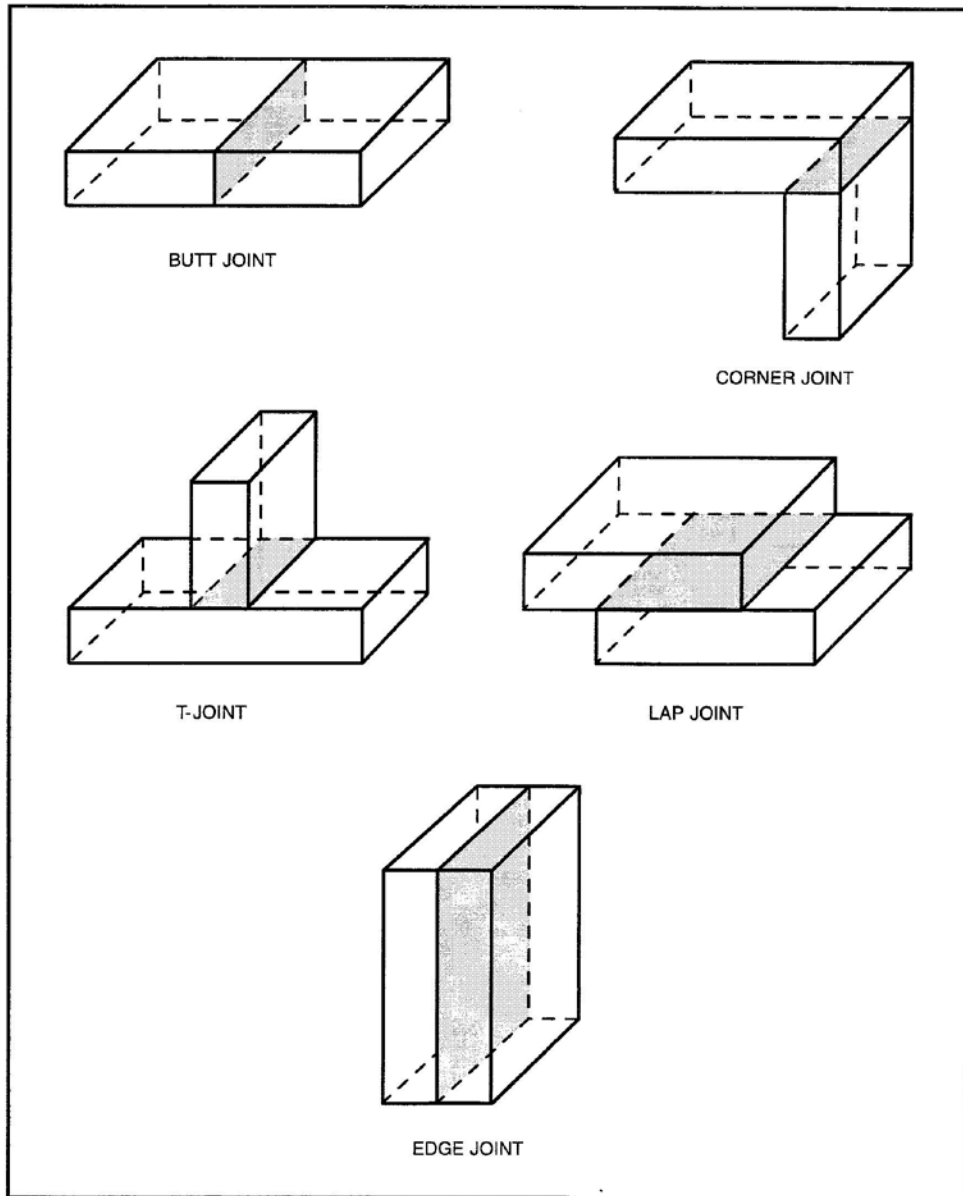
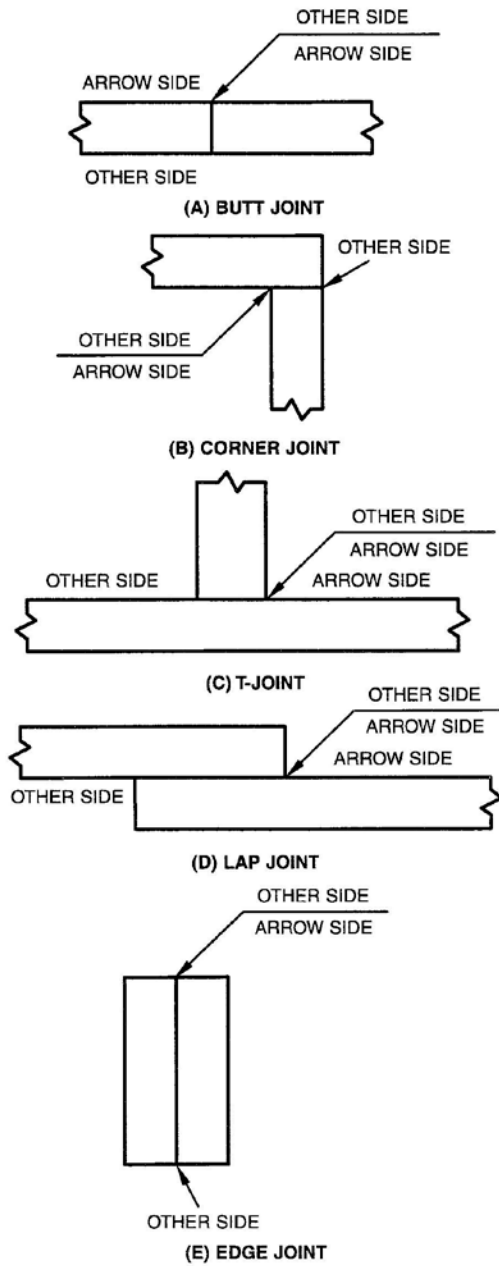


Figure 4—Joint Types

5. General Provisions for Welding Symbols

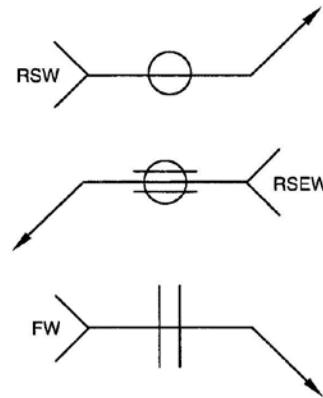
5.1 Location Significance of the Arrow. Information applicable to the arrow side of a joint shall be placed below the reference line. Information applicable to the other side of a joint shall be placed above the reference line.



5.1.1 Fillet, Groove, and Edge Weld Symbols. For these symbols, the arrow shall contact the outer surface of one of the joints, and this side shall be considered the arrow side of the joint. The side opposite the arrow side of the joint shall be considered the other side of the joint (see Figure 5).

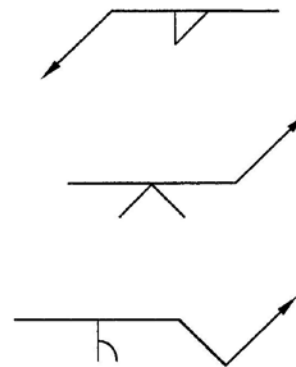
5.1.2 Plug, Slot, Spot, Projection, and Seam Weld Symbols. For these symbols, the arrow shall contact the outer surface of one of the joint members at the center-line of the desired weld. The member toward which the arrow points shall be considered the arrow-side member. The other joint member shall be considered the other-side member (see the figures cited in Clauses 8 through 11).

5.1.3 Symbols with No Side Significance. Some weld symbols have no arrow-side or other-side significance, although supplementary symbols used in conjunction with them may have such significance (see 10.1.2 and 10.1.4).



5.2 Location of the Weld with Respect to the Joint

5.2.1 Arrow Side. Welds on the arrow side of the joint shall be specified by placing the weld symbol below the reference line (see 5.1.1).



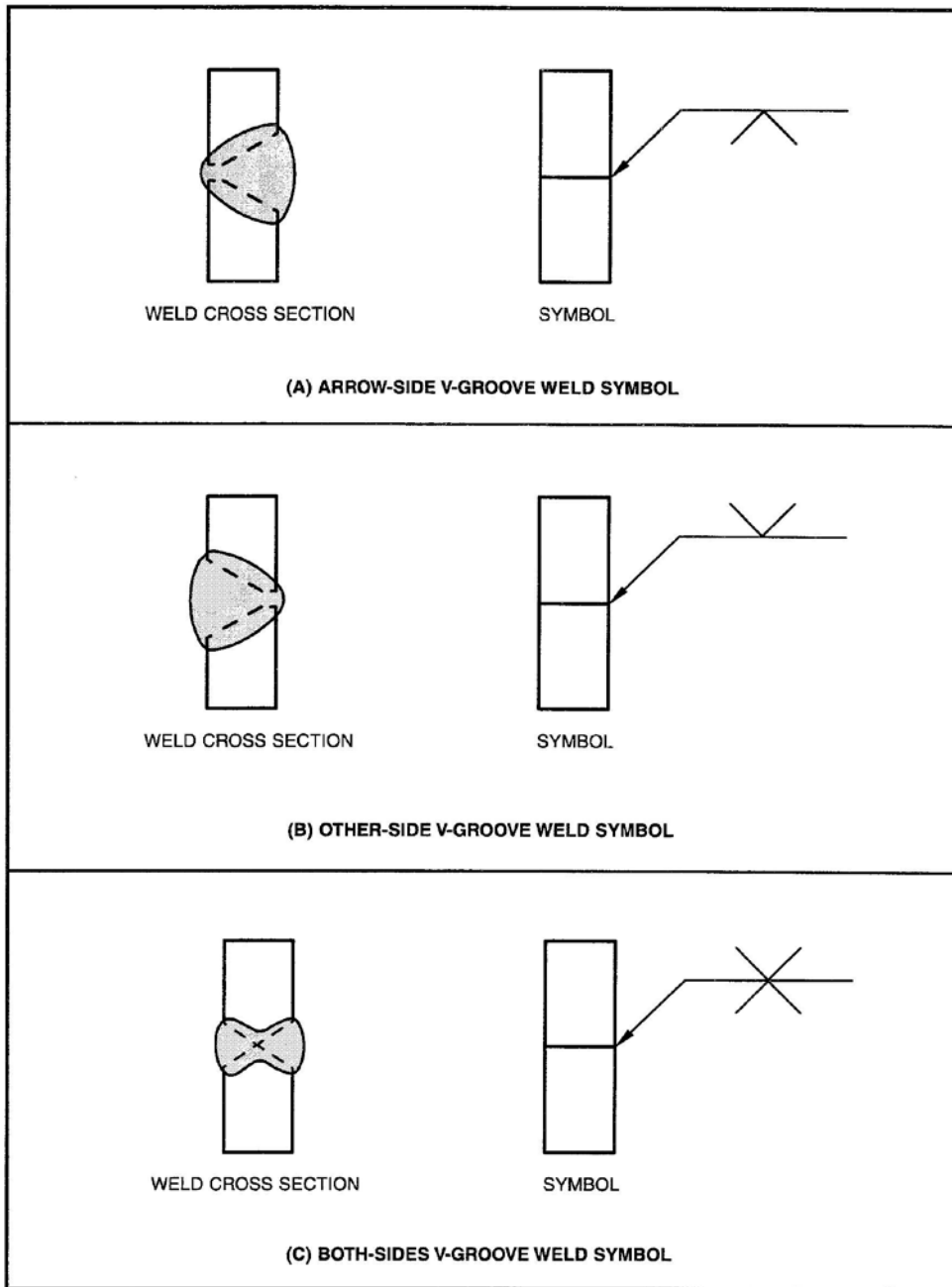
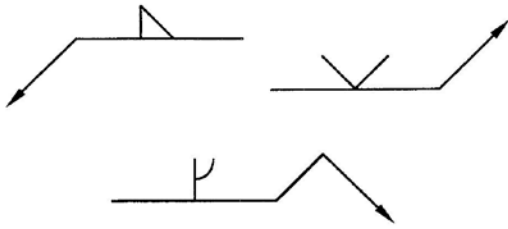


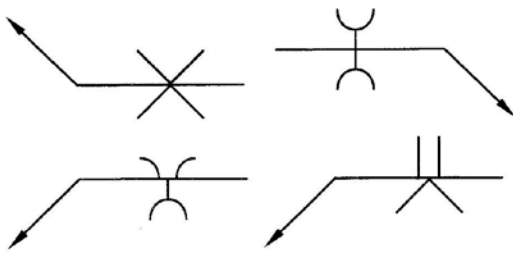
Figure 5—Application of Weld Symbols to Indicate the Arrow Side, the Other Side, and Both Sides

5.2.2 Other Side. Welds on the other side of the joint shall be specified by placing the weld symbol above the reference line (see 5.1.1).

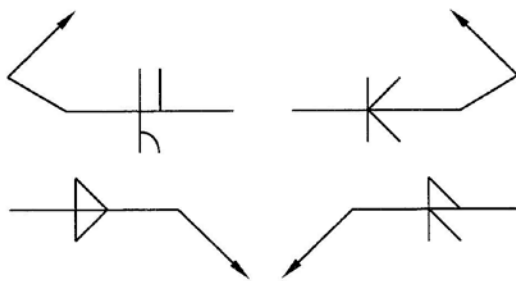


5.2.3 Both Sides. Welds on both sides of the joint shall be specified by placing weld symbols both below and above the reference line.

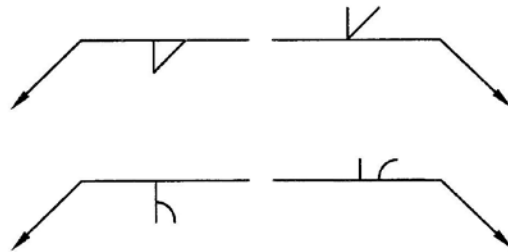
5.2.3.1 Symmetrical Weld Symbols. If the weld symbols used on both sides of the reference line have axes of symmetry that are perpendicular or normal to the reference line, these axes of the symbols shall be directly aligned across the reference line. Staggered intermittent welds are an exception.



5.2.3.2 Nonsymmetrical Weld Symbols. If either of the weld symbols used lacks an axis of symmetry perpendicular or normal to the reference line, the left sides of the weld symbols shall be directly aligned across the reference line. Staggered intermittent welds are an exception.

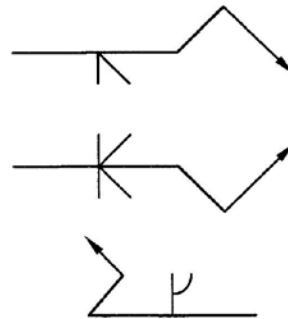


5.3 Orientation of Specific Weld Symbols. Fillet, bevel-groove, J-groove, and flare-bevel-groove weld symbols shall be drawn with the perpendicular leg always to the left.



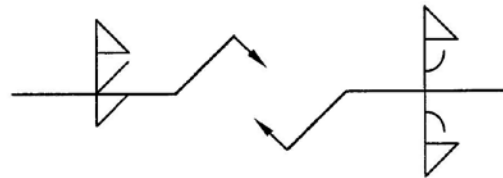
5.4 Break in the Arrow

5.4.1 Groove Welds. When only one joint member is to have a bevel-groove or a J-groove or both, the arrow shall have one break and point toward that member (see Figure 6). The arrow need not be broken if it is apparent which member is to have the bevel- or J-groove (see Figure 7). It shall not be broken if there is no preference as to which member is to have the bevel- or J-groove. A broken arrow need not be used for joints in which combined welds are to be specified and it is apparent which member is to be beveled.



5.4.2 Fillet Welds. The arrow may or may not be broken to indicate fillet weld locations [see Figures 9 and 33(A)].

5.5 Combination Weld Symbols. For joints requiring more than one weld type, a symbol shall be used to specify each weld (see Figure 7).



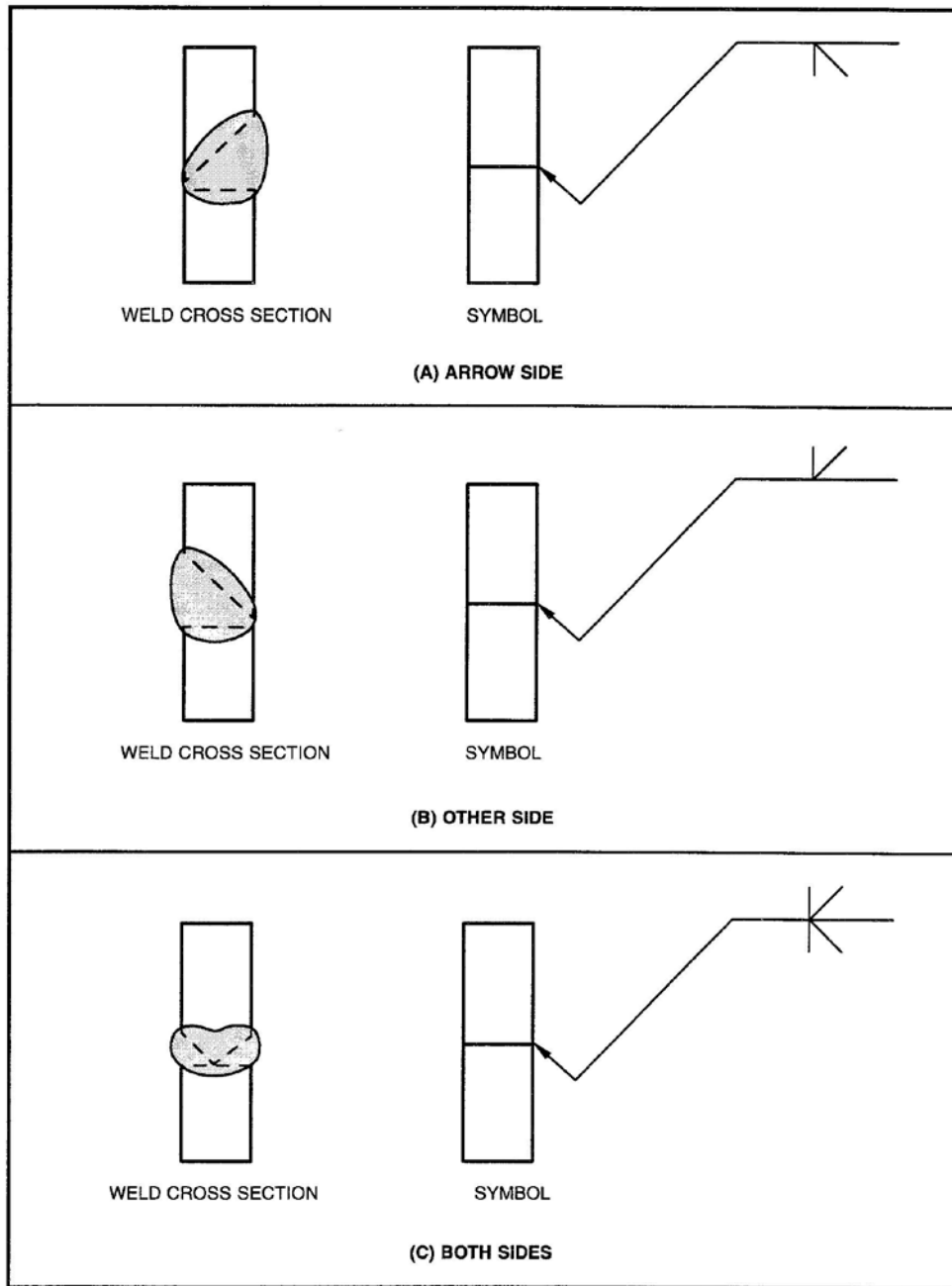


Figure 6—Applications of the Break in the Arrow of the Welding Symbol

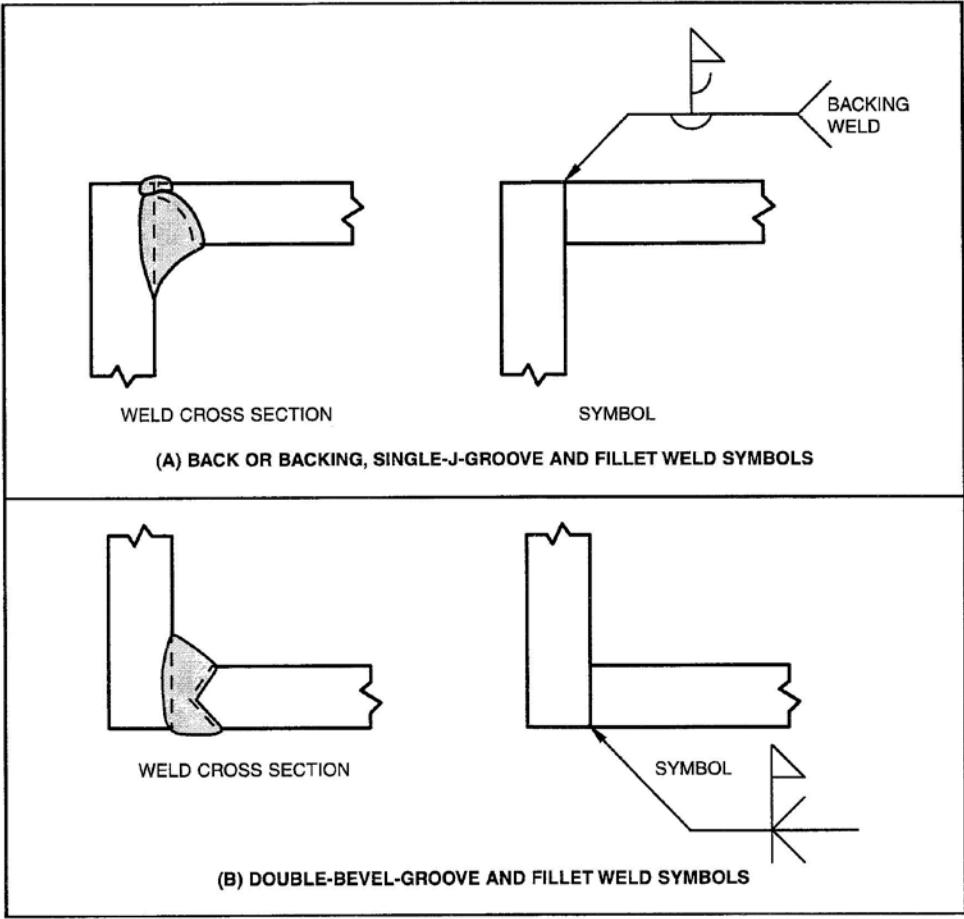


Figure 7—Combination Weld Symbols

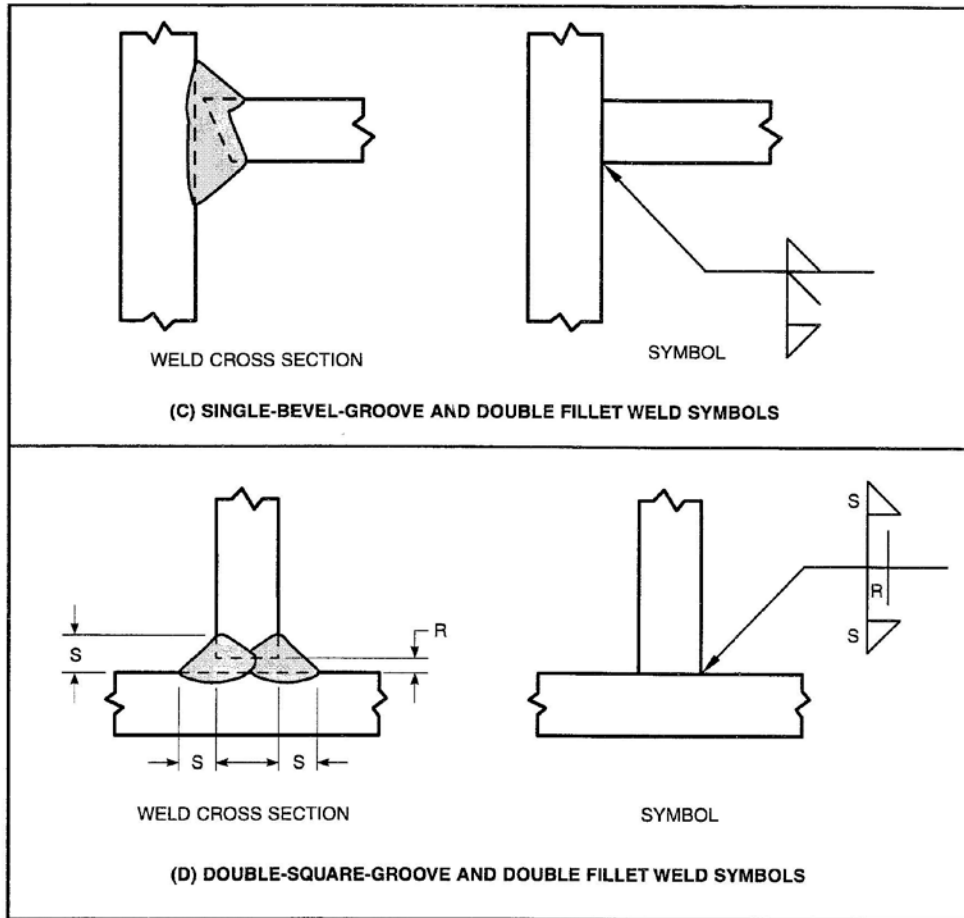
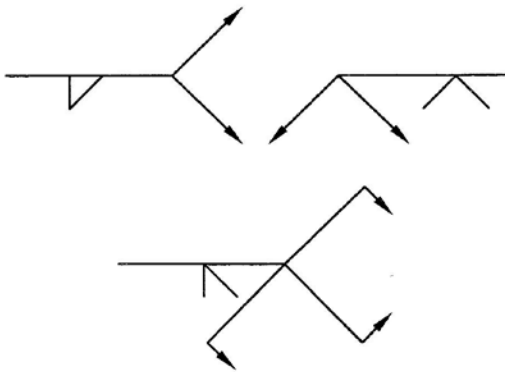


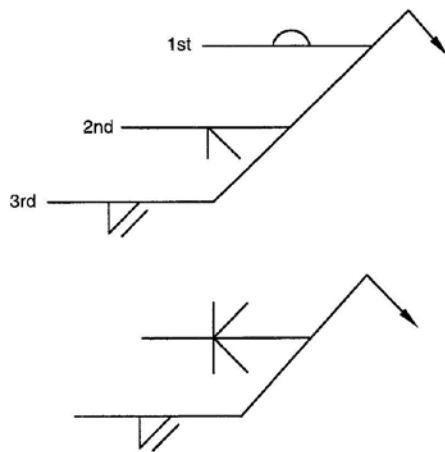
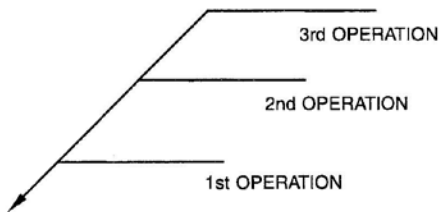
Figure 7 (Continued)—Combination Weld Symbols

5.6 Multiple Arrow Lines. Two or more arrows may be used with a single reference line to point to locations where identical welds are specified [see Figures 9(A) and 10].

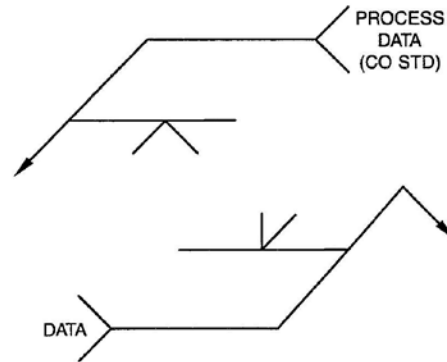


5.7 Multiple Reference Lines

5.7.1 Sequence of Operations. Two or more reference lines may be used to indicate a sequence of operations. The first operation is specified on the reference line nearest the arrow. Subsequent operations are specified sequentially on additional reference lines.

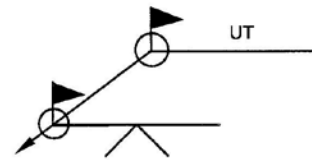


5.7.2 Supplementary Data. The tail of additional reference lines may be used to specify data supplementary to welding symbol information.

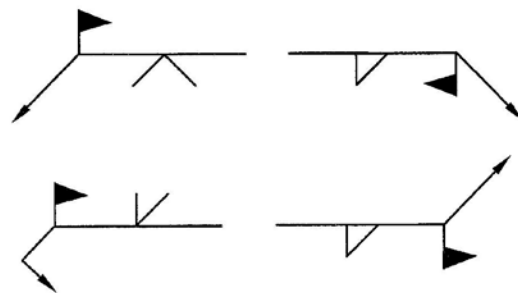


5.7.3 Field Weld and Weld-All-Around Symbols.

When required, the weld- (or examine-) all-around symbol shall be placed at the junction of the arrow and the reference line for each operation to which it is applicable. The field weld symbol may also be applied to the same location.



5.8 Field Weld Symbol. A flag is used to specify a field weld. The flag shall be placed at a right angle to, and on either side of, the reference line at the junction with the arrow (see Annex D5.8).



5.9 Extent of Welding Denoted by Symbols

5.9.1 Weld Continuity. Unless otherwise indicated, welding symbols shall denote continuous welds.

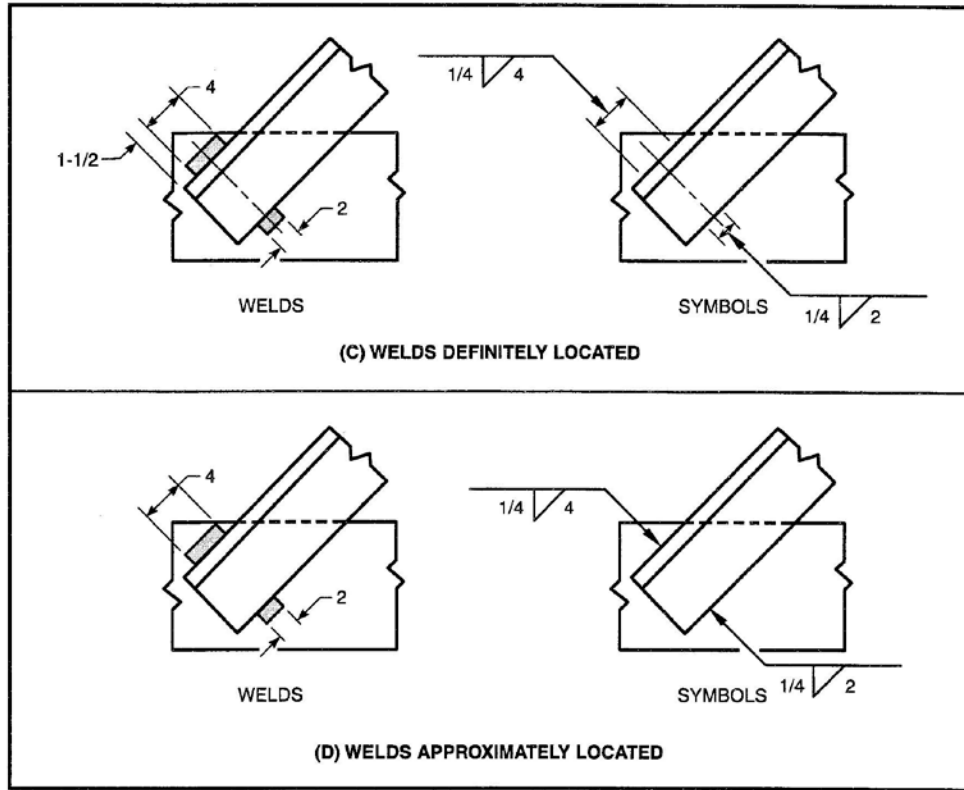


Figure 8 (Continued)—Specification of the Location and Extent of Fillet Welds

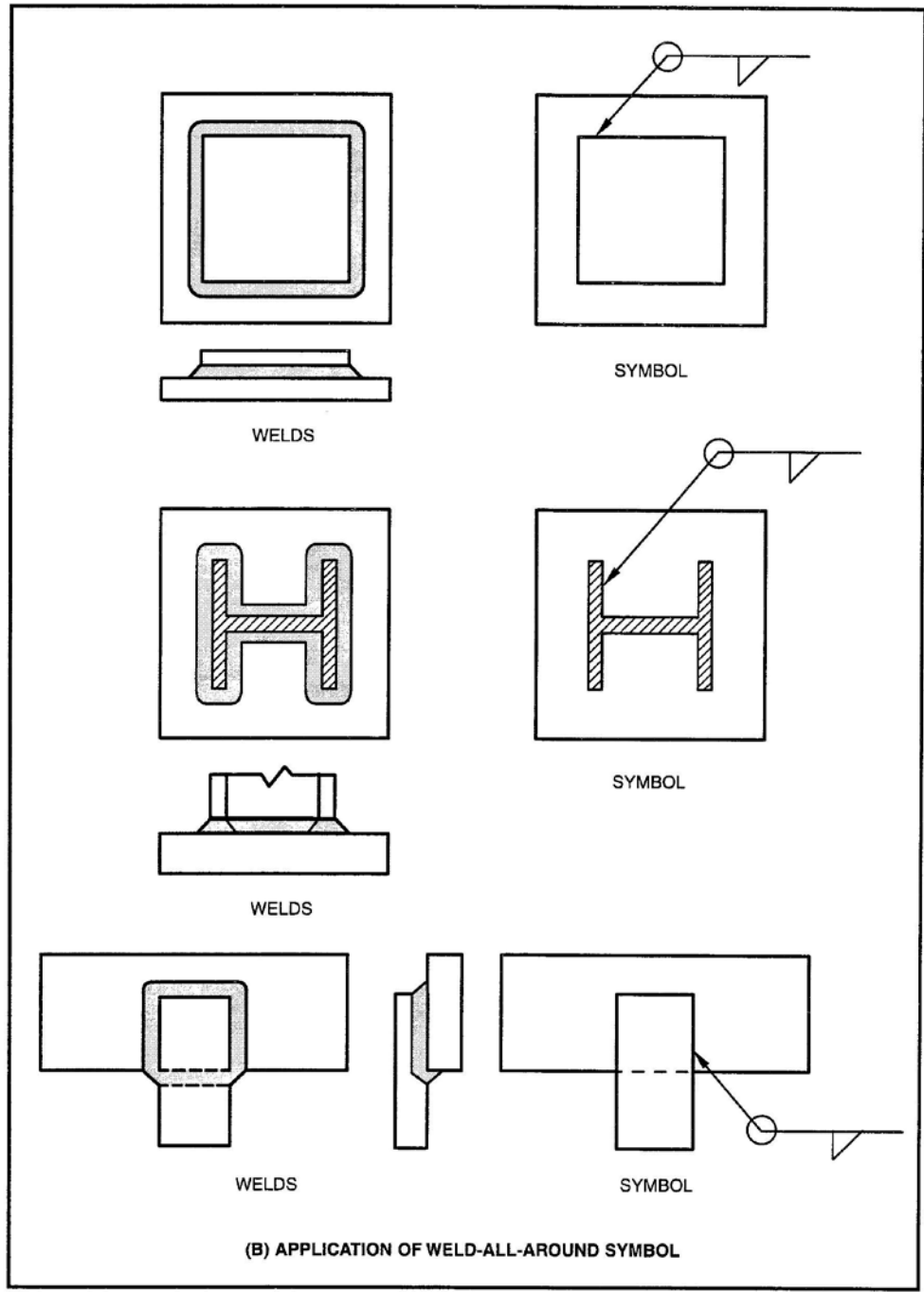


Figure 9 (Continued)—Application of the Symbol for the Specification of the Extent of Welding

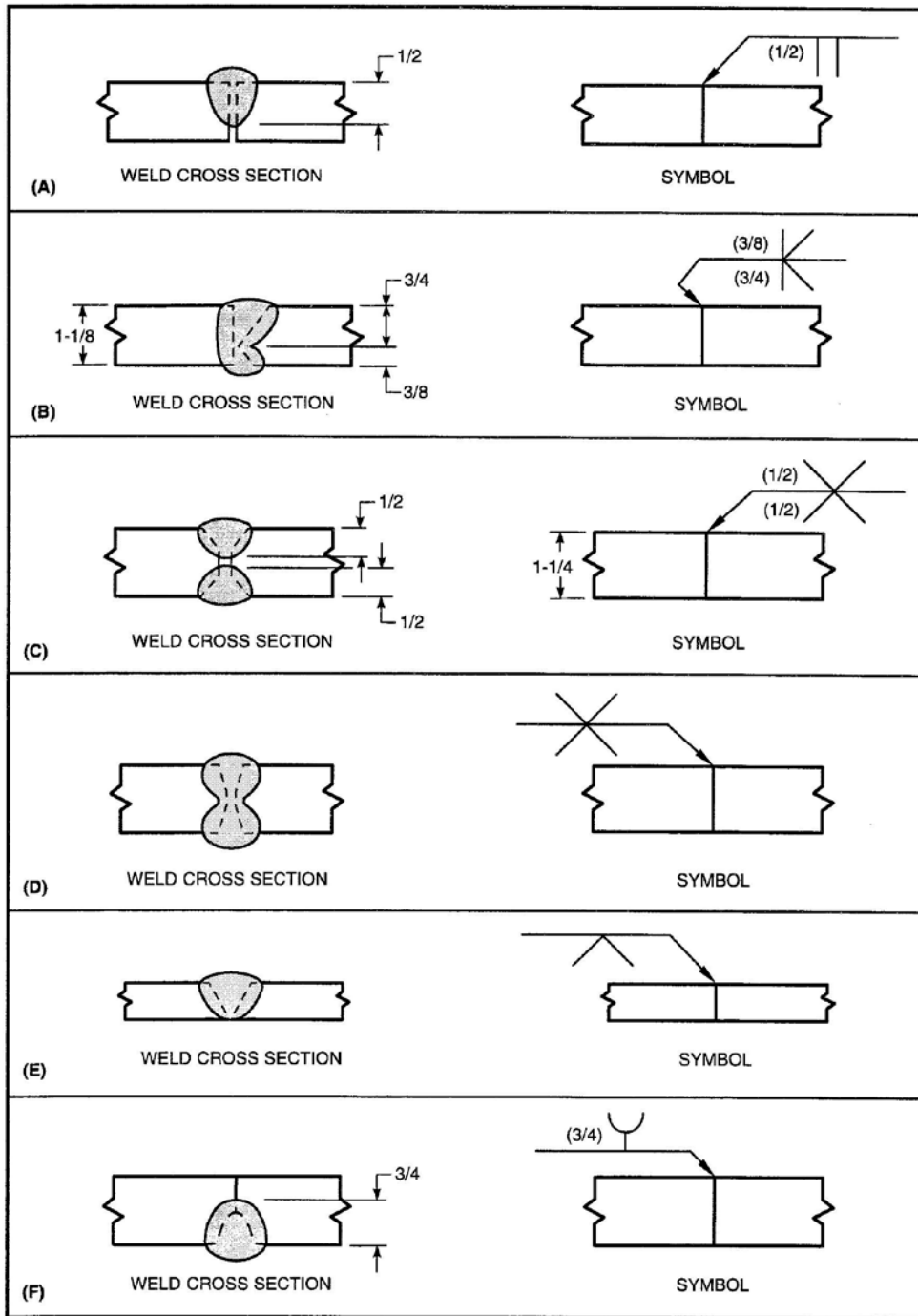


Figure 12—Specification of Groove Weld Size, Depth of Bevel Not Specified

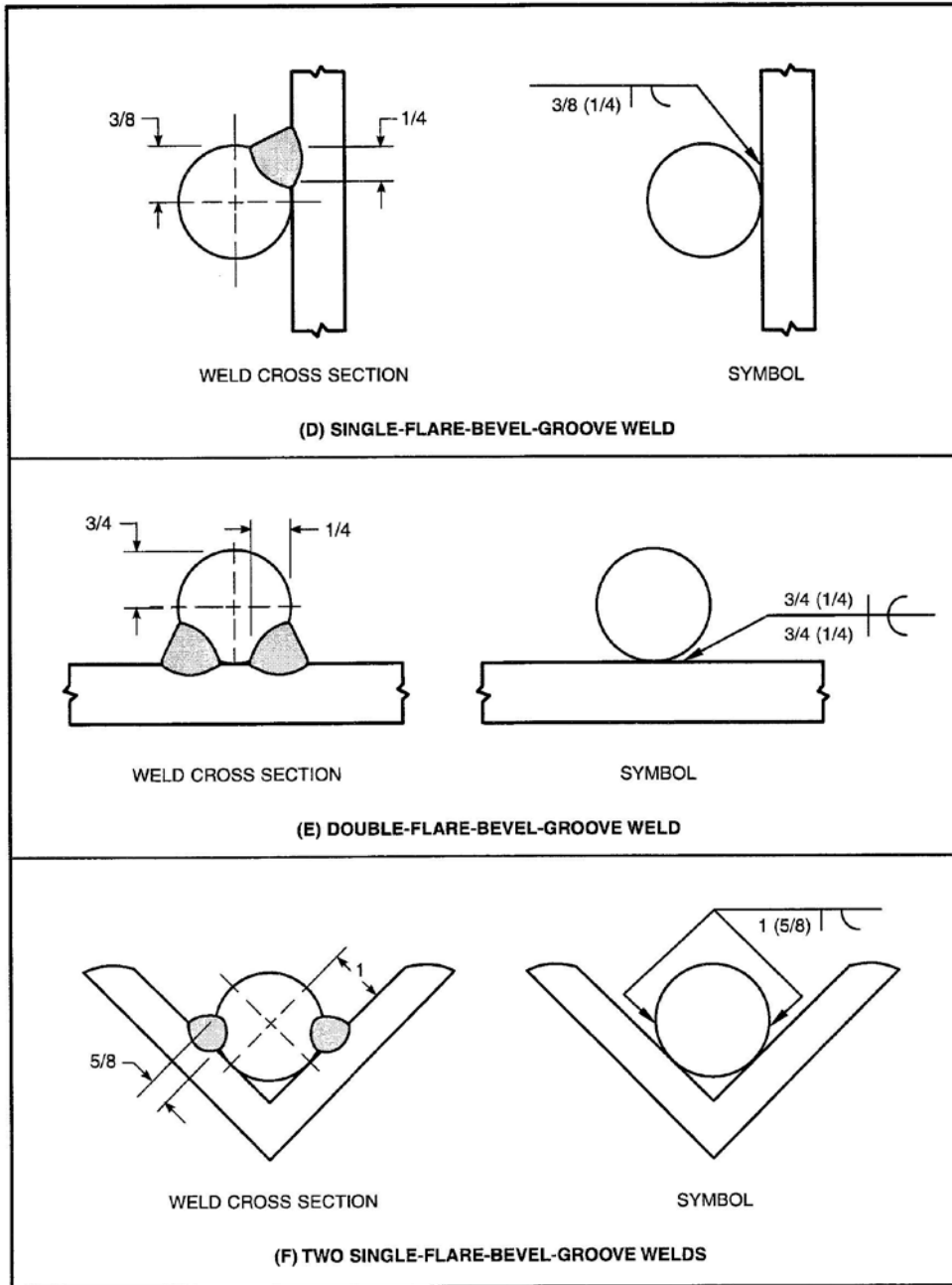


Figure 22 (Continued)—Applications of Flare-Bevel and Flare-V-Groove Weld Symbols

7.3.2 Changes in Direction of Welding. Symbols for fillet welds involving changes in the direction of welding shall be in accordance with 5.9.2 [see Figure 9(A)].

7.4 Intermittent Fillet Welds

7.4.1 Pitch. The pitch of intermittent fillet welds shall be the distance between the centers of adjacent weld segments on one side of the joint [see Figure 33(A)].

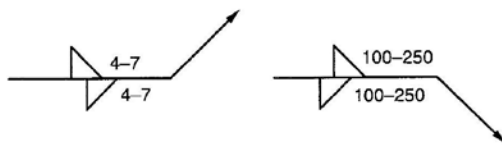
7.4.2 Pitch Dimension Location. The pitch of intermittent fillet welds shall be specified to the right of the length dimension following a hyphen (see Figure 33).



7.4.3 Chain Intermittent Fillet Welds. Dimensions of chain intermittent fillet welds shall be specified on both sides of the reference line. The segments of chain intermittent fillet welds shall be opposite one another across the joint [see Figure 33(B)].



7.4.4 Staggered Intermittent Fillet Welds. The dimensions of staggered intermittent fillet welds shall be specified on both sides of the reference line, and the fillet weld symbols shall be offset on opposite sides of the reference line as shown below. The segments of staggered intermittent fillet welds shall be symmetrically spaced on both sides of the joint as shown in Figure 33(C).



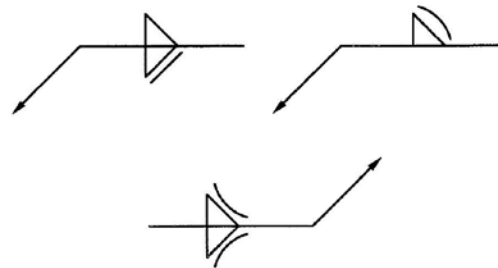
7.4.5 Extent of Welding. In the case of intermittent fillet welds, additional weld lengths that are intended at the ends of the joint shall be specified by separate welding symbols and dimensioned on the drawing [see Figure 33(D)]. When no weld lengths are intended at the ends of the joint, the unwelded lengths should not exceed the clear distance between weld segments and be so dimensioned on the drawing [see Figure 33(E)].

7.4.6 Location of Intermittent Welds. When the location of intermittent welds is not obvious, such as on a circular weld joint, it will be necessary to provide specific segment locations by dimension lines (see 6.4.1.2 and 7.3.1.2) or by hatching (see 6.4.1.3 and 7.3.1.3).

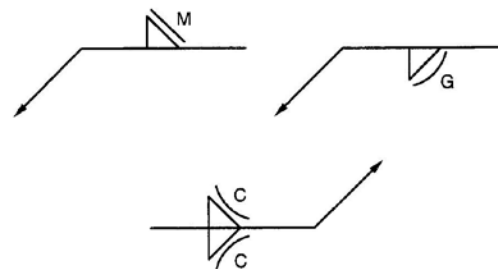
7.5 Fillet Welds in Holes and Slots. Fillet welds in holes and slots shall be specified by the use of fillet weld symbols [see Figure 34(A)].

7.6 Contours and Finishing of Fillet Welds

7.6.1 Contours Obtained by Welding. Fillet welds that are to be welded with approximately flat, convex, or concave faces without postweld finishing shall be specified by adding the flat, convex, or concave contour symbol to the welding symbol (see 5.12.1).



7.6.2 Contours Obtained by Postweld Finishing. Fillet welds that are to be finished approximately flat, convex, or concave by postweld finishing shall be specified by adding both the appropriate contour symbol and finishing designator to the welding symbol (see 5.12.2).



7.7 Skewed Joints. When the angle between the fusion faces is such that the identification of the weld type and thus the proper weld symbol may be in question, the detail of the desired joint and weld configuration shall be shown on the drawing (see 6.13 and Figure 31).

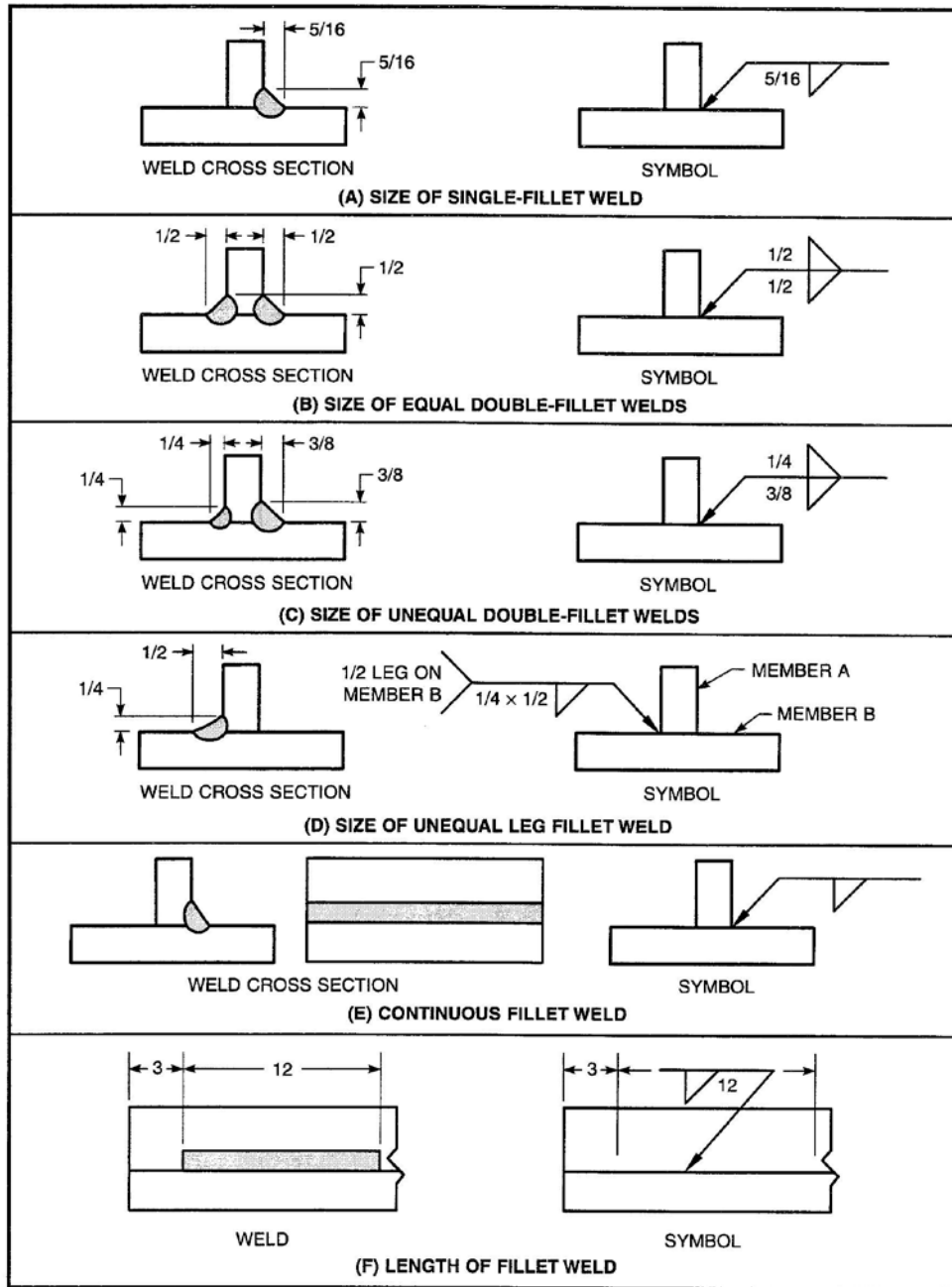


Figure 32—Application of the Symbols for the Size and Length of Fillet Welds

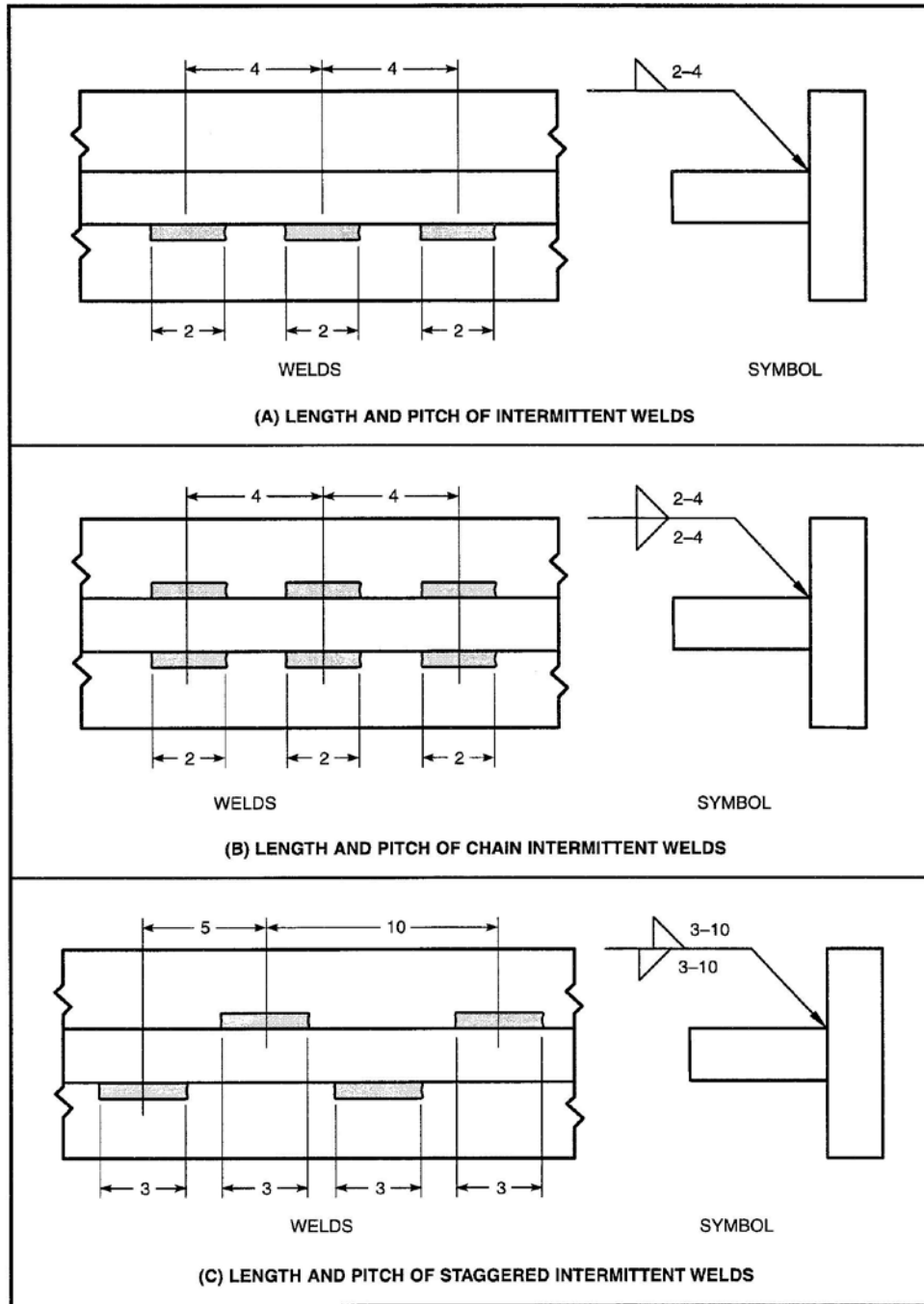


Figure 33—Application of the Intermittent Fillet Weld Symbol

Appendix D

References

AASHTO/AWS D1.5M/D1.5: Bridge Welding Code
AASHTO/AWS D1.1M/D1.1: Structural Welding Code
AWS A2.4: Standard Symbols for Welding, Brazing, and Nondestructive Examination
AWS A3.0: Standard Welding Terms and Definitions
North Carolina Department Of Transportation Standard Specifications for Roads and Structures
SSPC (Steel Structures Painting Council) Painting Manual Volume 2 Eighth Edition

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The material presented in this manual was compiled by Randy Dempsey, CWI/CWE, NCDOT Engineering Technician

This Manual was authorized by C. David Greene, PE, NCDOT Structures Engineer and Steve Walton, NCDOT Metals Engineer with technical assistance provided by NCDOT Engineering Technicians, Gary Bristow, Eddie Shelar, David E. Greene, John Andrews, CWI, Steven Burke, Richard Maxon, CWI, Christopher Lee, CWI and Mike Pulley, CWI.

Steel Section Contact Information

C. David Greene, JR., PE Structural Members Engineer 919-329-4200 dgreene@ncdot.gov	Steve Walton Metals Engineer 336-993-2300 mobile: 336-406-6502 swalton@ncdot.gov	Gary Bristow Engineering Technician 336-993-2300 mobile: 336-409-1178 gbristow@ncdot.gov
Eddie Shelar Engineering Technician 336-256-2568 mobile: 336-601-2647 gshelar@ncdot.gov	David E Greene Engineering Technician 336-256-2568 mobile: 336-553-7045 davegreene@ncdot.gov	John E Andrews, CWI Engineering Technician mobile: 803-221-6608 jeandrews@ncdot.gov
Steven F Burke Engineering Technician mobile: 919-524-5203 sburke@ncdot.gov	Randy Dempsey, CWI/CWE Engineering Technician 336-993-2300 mobile: 336-970-1436 rddempsey@ncdot.gov	Richard Maxon, CWI Engineering Technician 336-993-2300 mobile: 336-757-2010 rdmaxon@ncdot.gov
Christopher M Lee, CWI Engineering Technician 919-553-3034 mobile: 252-373-0176 cmlee@ncdot.gov	Michael Pulley, CWI Engineering Technician 252-459-7116 mobile: 252-343-7237 mwpulley@ncdot.gov	

Appendix E

List of Revisions

The revisions from the May 2010 edition to the 2011 edition of the NCDOT Field Welding Procedures Manual are as follows:

1. **Front Cover**-Change all photos.
2. **Cover Sheet**-Change the edition date from "May 2010" to "4th Edition-June 2011".
3. **Table of Contents**-Change the line spacing and indentation. Add: "Cover Sheet", "Table of Contents", the topics that are presented in the General Information, welding procedures 16 thru 28 (procedures 19 and 20 are only on S drive under Structural Members), Appendix E.
4. **Introduction**-Add: " Additional information and procedures have been included to assist Bridge Maintenance Personnel with "Repair of Existing Structures". Add information about previous editions.
5. **General Information- Reference Standards (note)**-Change the letter from "A" to "B" for the appendix reference . Added: AWS D-1.5 Sections 1.1.1 3.2.2, 3.2.4, 3.6.1.1, 3.6.2, 3.6.5, 3.7.2, 3.7.2.1, 3.7.2.2, 3.7.2.3, 3.7.2.4, 3.11.1, 3.11.2, 3.13.5, 4.2.7, 4.5.2 (second portion of the paragraph), 6.26.1, 6.26.1.1, 6.26.1.2, 6.26.1.3, 6.26.1.4, 6.26.1.5, comment about 6.26.1.6, 6.26.1.7, C-6.26.1, C-6.5, a comment about stud welding using automatic equipment, 7.4.1, 7.4.2, 7.5.5, 7.5.5.3, 7.5.5.4.
6. **WPS 001**-Add the parameters for a 5/32" electrode, changed the interpass maximum to 450°, changed the revision number to 4, changed the bevel angle tolerance from -0° to -5°.
7. **WPS 002**-Change the interpass maximum to 450°, change the revision number to 4.
8. **WPS 003**- Change the interpass maximum to 450°, change the revision number to 5, add the parameters for a 5/32" electrode, changed the bevel angle tolerance from -0° to -5°, omit the root face dimension, change the root opening to 1/4" +5/16" -1/16", change the bevel angle on the horizontal detail to 45°.
9. **WPS 004**-Change the interpass maximum to 450°, change the revision number to 4.
10. **WPS 005**-Change the interpass maximum to 450°, change the revision number to 5.
11. **WPS 006**-Change the interpass maximum to 450°, change the revision number to 4.
12. **WPS 007**-Change the interpass maximum to 450°, change the revision number to 4, add the statement in the comments "Remove the protrusion from the bottom of the stud".
13. **WPS 008**- Change the interpass maximum to 450°, change the revision number to 3.
14. **WPS 009**- Change the interpass maximum to 450°, change the revision number to 3, omit the tolerance for the bevel angle.
15. **WPS 010**- Change the interpass maximum to 450°, change the revision number to 3, Change the bevel angle to 60°.
16. **WPS 011**- Change the interpass maximum to 450°, change the revision number to 3.
17. **WPS 012**- Change the interpass maximum to 450°, change the revision number to 3, add the parameters for a 5/32" electrode, changed the bevel angle tolerance from -0° to -5°, omit the root face dimension, change the root opening to 1/4" +5/16" -1/16", change the bevel angle to 45°.
18. **WPS 013**- Change the interpass maximum to 450°, change the revision number to 2.
19. **WPS 014**- Change the interpass maximum to 450°, change the revision number to 2.
20. **WPS 015**- Change the interpass maximum to 450°, change the revision number to 2.

Appendix E

List of Revisions (cont.)

21. Add welding procedures 016 through 029.
22. **Appendix A**-Add the following terms and definitions: convexity, porosity, weld, welding. Add a photo for porosity and the figures for "Parts of a Weld".
23. **Appendix D**-Add D1.1 reference, a paragraph for credits and a table for steel section contact information.
24. Add appendix E, list of revisions.
25. Change all welding parameters from Hobart recommendations to Lincoln recommendations.
26. Add page numbering to the TOC, Introduction, General Information, Welding Procedures, Appendix A and D.
27. Make numerous changes to fonts, spacing, etc. to improve the consistency of the manual.
28. Add photographic illustrations to the welder certification procedures.
29. Add fit-up photographic illustrations for the H-Pile Welding Procedure.
30. A contractor version has been generated that does not include the photo cover, welding procedure photographic illustrations or, due to copy write issues, sspc standards (Appendix B).