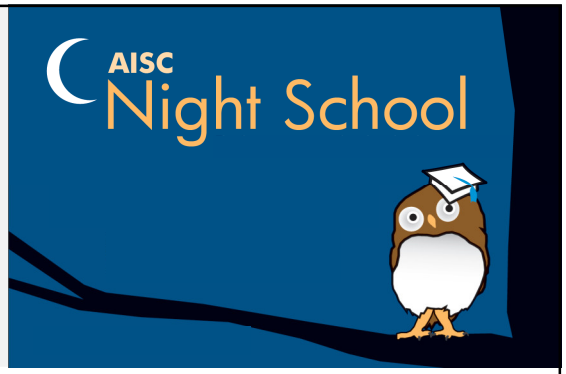
Thank you for joining our live webinar today.

We will begin shortly.
Please standby. Thank you.

Need Help?
Call ReadyTalk Support:
800.843.9166



Welded Connections

A Primer for Engineers

Smarter. Stronger. Steel.

AISC Night School

Audio Options

Today's audio will be broadcast through the internet.

Alternatively, to hear the audio through the phone, dial:

(866)-519-2796
Passcode: 254072

Smarter. Stronger. Steel.

AISC Night School

Today's live webinar will begin shortly. Please stand by.

As a reminder, all lines have been muted. Please type any questions or comments through the chat feature on the left portion of your screen.

Today's audio will be broadcast through the internet.
Alternatively, to hear the audio through the phone, dial:

(866)-519-2796
Passcode: 254072

Smarter. Stronger. Steel.

AISC Night School

AIA Credit

AISC is a Registered Provider with The American Institute of Architects Continuing Education Systems (AIA/CES). Credit(s) earned on completion of this program will be reported to AIA/CES for AIA members. Certificates of Completion for both AIA members and non-AIA members are available upon request.

This program is registered with AIA/CES for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product.

Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

Smarter. Stronger. Steel.

AISC Night School

Copyright Materials

Smarter. Stronger. Steel.

AISC Night School

Course Description

21.7 Special Welding Applications
December 3, 2019

This session covers atypical welding applications for buildings. The live webinar presents practical, straightforward solutions to challenging situations including: welding of steel headed stud anchors, welding on coated steels, welding AESS, welding on existing structures, welding heavy sections, welding under high restraint, field welding, heat shrinking, cold temperature applications and more.

Smarter. Stronger. Steel.

AISC Night School

Learning Objectives

- Describe tolerance issues that may affect welded connections in AESS structures.
- Identify welded HSS connections where member configurations could prevent proper welding, inspection or assembly.
- List considerations for welded connections on rolled heavy shapes.
- List consideration for welded connections in cold temperature applications

Smarter. Stronger. Steel.

AISC Night School

Night School 21 Course Schedule

10/8/2019 1. Introduction and Weld Processes
10/15/2019 2. Principles of Welded Connections
10/29/2019 3. Welded Connection Details
11/5/2019 4. Metallurgy and Cracking
11/19/2019 5. Fatigue of Welded Connections
11/26/2019 6. Seismic Welding Issues
12/3/2019 7. Special Welding Applications
12/10/2019 8. Problems and Fixes

Smarter. Stronger. Steel.

Night School 21
Welded Connections --
A Primer for Engineers

Session 7: Special Welding Applications
December 3, 2019

Duane K. Miller, PE, ScD
Manager of Engineering Services and Welding
Design Consultant

LINCOLN ELECTRIC

Smarter. Stronger. Steel.

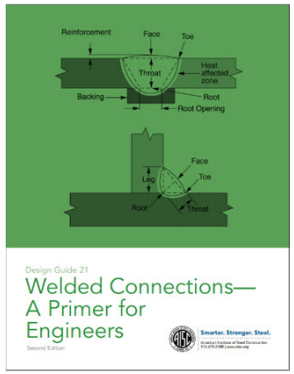
SPECIAL WELDING APPLICATIONS

10

AISC Design Guide 21, 2nd Edition

Welded Connections–

A Primer for Engineers



11

SPECIAL WELDING APPLICATIONS

Chapter 14 Special Welding Applications

14.1 Welding of Steel Headed Stud Anchors

14.2 Welding on Galvanized Steels

14.3 Welding on Primed and Painted Steel

14.4 Welding on Heavy Shapes

14.5 Welding on Highly Restrained Members

14.6 Welding HSS

12

SPECIAL WELDING APPLICATIONS

14.7 Welding AESS

14.8 Shop Versus Field Welding

14.9 Welding on Existing Structures

14.10 Welds and Mechanical Fasteners

14.11 Welding on Members to be Hot-Dip Galvanized

14.12 Cold Temperature Applications

14.13 Deck Welding

13

SPECIAL WELDING APPLICATIONS

14.14 Welding on In-Place Embed Plates

14.15 Heat Shrinking

14.16 Buttering

14

SPECIAL WELDING APPLICATIONS

Today's Webinar

→ 14.4 Welding on Heavy Shapes

14.6 Welding HSS

14.7 Welding AESS

14.8 Shop Versus Field Welding

14.9 Welding on Existing Structures

14.12 Cold Temperature Applications

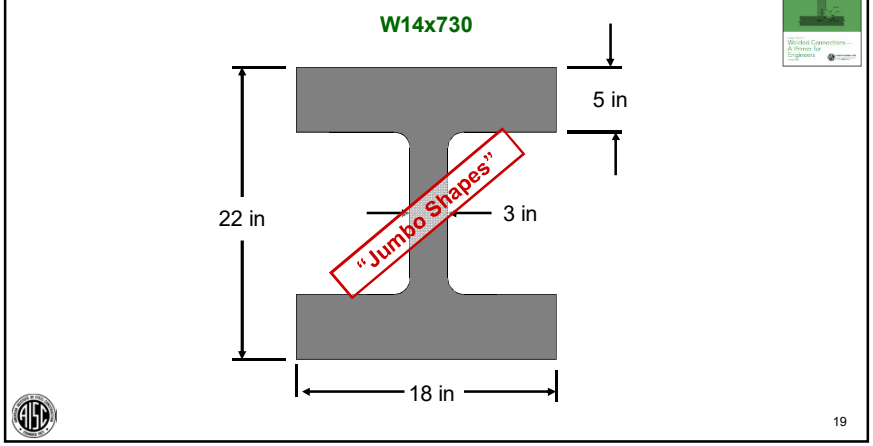
14.15 Heat Shrinking

14.16 Buttering

15

16

SPECIAL WELDING APPLICATIONS



AISC 360-16 SPECIFICATION

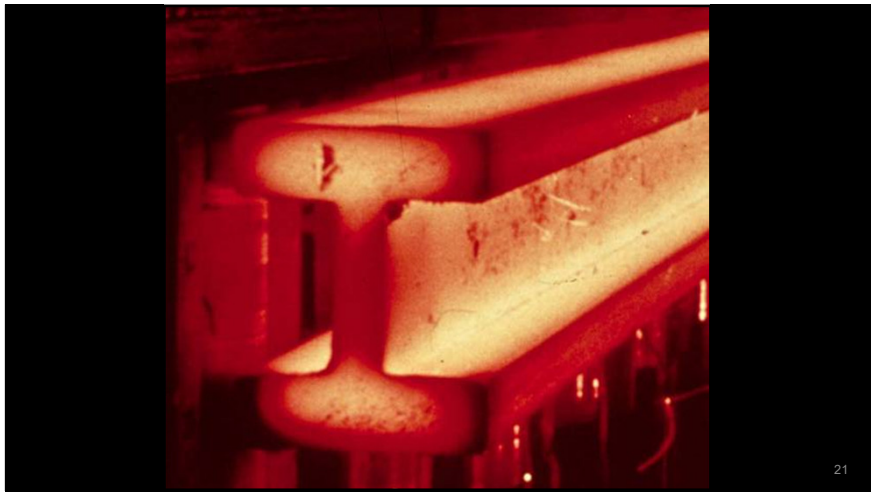
Commentary A3

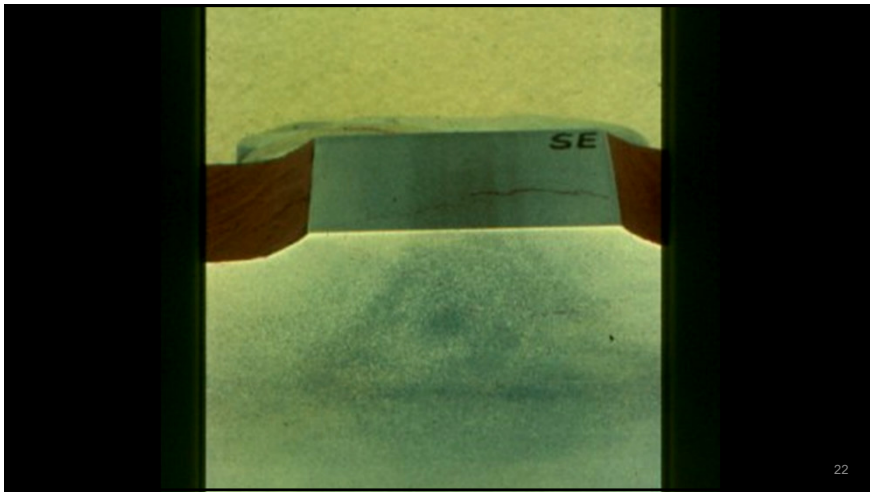
1c. Rolled Heavy Shapes

The web-to-flange intersection and the web center of heavy hot-rolled shapes, as well as the interior portions of heavy plates, may contain a more coarse grain structure and/or lower notch toughness material than other areas of these products.

Segregation **Reduced Rolling** **Slower Cooling**

20





AISC 360-16 Specification for Structural Steel Buildings

Commentary A3

1c. Rolled Heavy Shapes

This characteristic is not detrimental to suitability for compression members or for non-welded members. However, when heavy cross sections are joined by splices or connections using complete-joint-penetration groove welds that extend through the coarser and/or low notch-tough interior portions, tensile strains induced by welding may result in cracking.

23

AISC 360-16 Specification for Structural Steel Buildings

Commentary A3

1a. ASTM Designations

Rolled Steel is anisotropic, especially insofar as ductility is concerned; therefore, weld contraction strain in the region of highly restrained welded connections may exceed the strength of the material if special attention is not given to material selection, details, workmanship and inspection.

Material | Details | Workmanship | Inspection

24

AISC 360-16 Specification for Structural Steel Buildings

Material

CHAPTER A
GENERAL PROVISIONS

A3. MATERIAL

1c. Rolled Heavy Shapes

ASTM A6/A6M hot-rolled shapes with a flange thickness exceeding 2 in. (50 mm) are considered to be rolled heavy shapes. Rolled heavy shapes used as members subject to primary (computed) tensile forces due to tension or flexure and spliced or connected using complete-joint-penetration groove welds that fuse through the thickness of the flange or the flange and the web, shall be specified as follows. The structural design documents shall require that such shapes be supplied with Charpy V-notch (CVN) impact test results in

25

AISC 360-16 Specification for Structural Steel Buildings

Material

CHAPTER A
GENERAL PROVISIONS

A3. MATERIAL

1c. Rolled Heavy Shapes (cont'd)

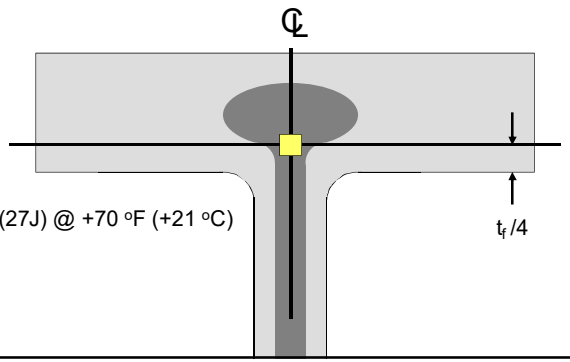
The structural design documents shall require that such shapes be supplied with Charpy V-notch (CVN) impact test results in accordance with ASTM A6/A6M, Supplementary Requirement S30, Charpy V-Notch Impact Test for Structural Shapes—Alternate Core Location. The impact test shall meet a minimum average value of 20 ft-lb (27 J) absorbed energy at a maximum temperature of +70°F (+21°C).

26

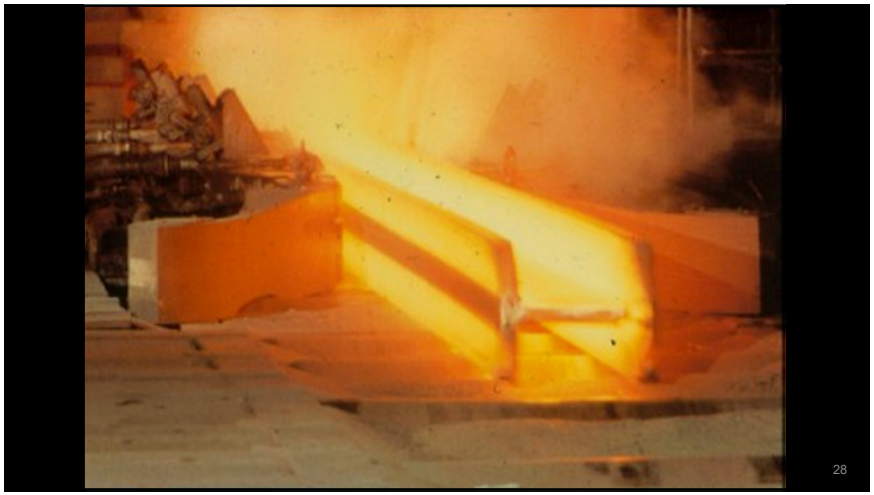
ASTM A6 Supplementary Requirements

Material

S30 Charpy V-Notch Impact Tests for Structural Shapes: Alternate Core Location



27



28

AISC 360-16 Specification for Structural Steel Buildings

Material

CHAPTER A
GENERAL PROVISIONS

A3 MATERIAL

1d. Built-Up Heavy Shapes

Built-up cross sections consisting of plates with a thickness exceeding 2 in. (50 mm) are considered built-up heavy shapes. Built-up heavy shapes used as members subject to primary (computed) tensile forces due to tension or flexure and spliced or connected to other members using complete-joint-penetration groove welds that fuse through the thickness of the plates, shall be specified as follows. The structural design documents shall require that the steel be supplied with Charpy V-notch impact test results in accordance with ASTM A6/A6M,

29

AISC 360-16 Specification for Structural Steel Buildings

Material

CHAPTER A
GENERAL PROVISIONS

A3 MATERIAL

1d. Built-Up Heavy Shapes (cont'd)

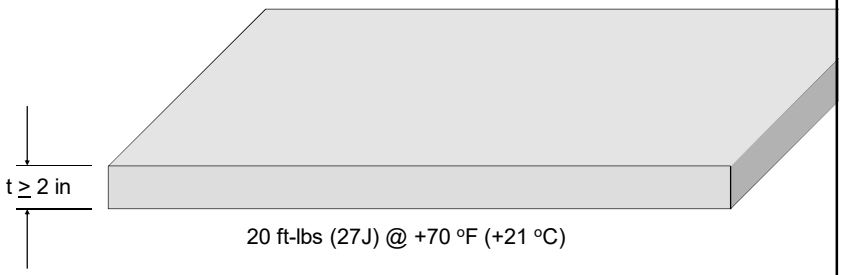
The structural design documents shall require that the steel be supplied with Charpy V-notch impact test results in accordance with ASTM A6/A6M, Supplementary Requirement S5, Charpy V-Notch Impact Test. The impact test shall be conducted in accordance with ASTM A673/A673M, Frequency P, and shall meet a minimum average value of 20 ft-lb (27 J) absorbed energy at a maximum temperature of +70°F (+21°C).

30

ASTM A6 Supplementary Requirements

Material

S5 Charpy V-Notch Impact Test



20 ft-lbs (27J) @ +70 °F (+21 °C)

For built-up cross sections

31

AISC 360-16 Specification for Structural Steel Buildings

Material

CHAPTER J
DESIGN OF CONNECTIONS

J2. 6. Filler Metal Requirements

Filler metal with a specified minimum Charpy V-notch toughness of 20 ft-lb (27 J) at 40°F (4°C) or lower shall be used in the following joints:

(a) CJP groove welded T- and corner joints with steel backing left in place, subject to tension normal to the effective area, unless the joints are designed using the nominal strength and resistance factor or safety factor, as applicable, for a PJP groove weld

(b) CJP groove welded splices subject to tension normal to the effective area in heavy sections, as defined in Sections A3.1c and A3.1d

32

AISC 360-16 Specification for Structural Steel Buildings

Material

J2.6 Filler Metal Requirements

20 ft-lbs (27J) @ +40 °F (+4 °C)

33

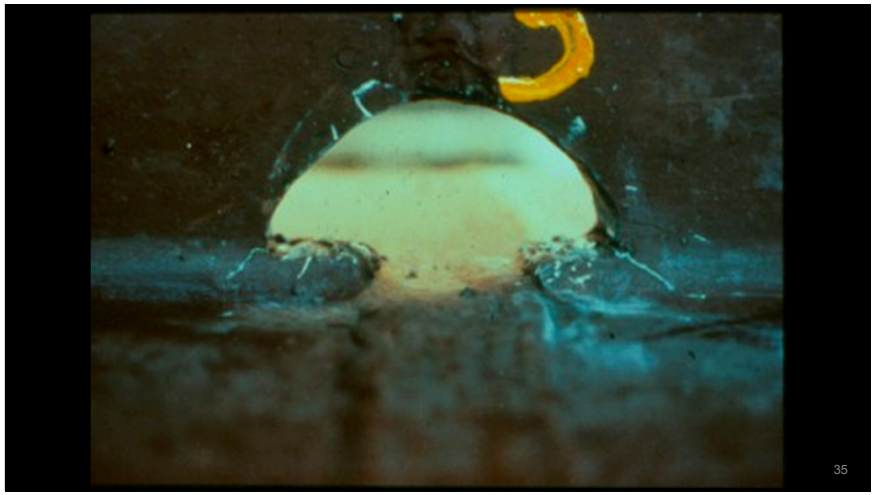
AISC 360-16 Specification for Structural Steel Buildings

Commentary A3

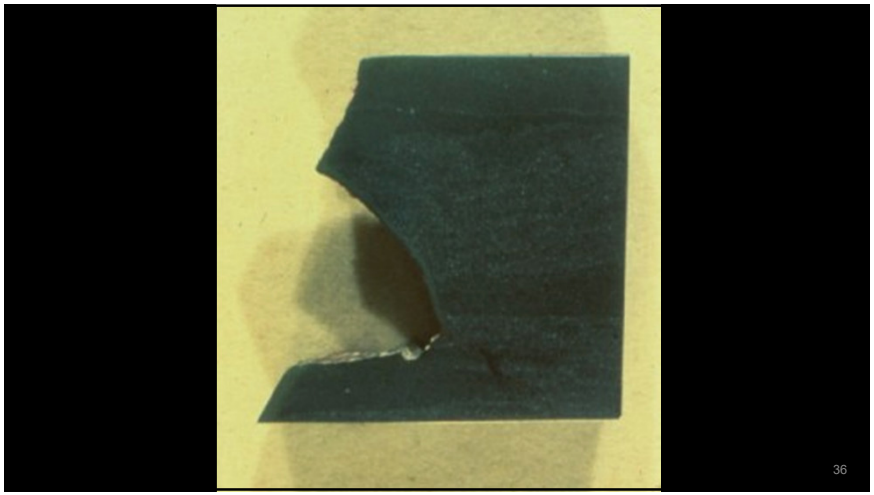
1c. Rolled Heavy Shapes

To minimize the potential for fracture, the notch toughness requirements of Section A3.1c must be used in conjunction with good design and fabrication procedures. Specific requirements are given in Sections J1.5, J1.6, J2.6 and J2.7.

34



35



36

AISC 360-16 Specification for Structural Steel Buildings

Details

CHAPTER J
DESIGN OF CONNECTIONS

J1.6. Weld Access Holes

Weld access holes shall meet the following requirements:

(a) All weld access holes required to facilitate welding operations shall be detailed to provide room for weld backing as needed.

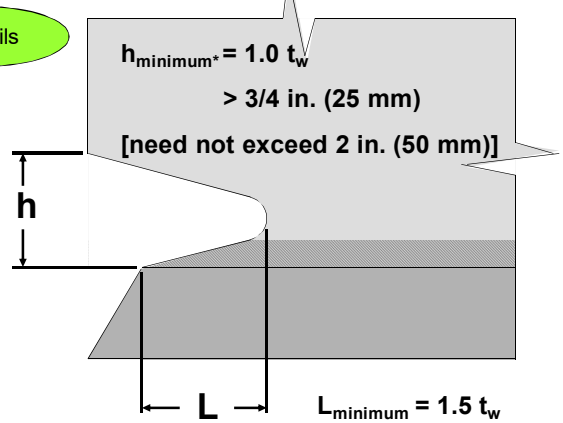
(b) The access hole shall have a length from the toe of the weld preparation not less than 1-1/2 times the thickness of the material in which the hole is made, nor less than 1-1/2 in. (38 mm).

(c) The access hole shall have a height not less than the thickness of the material with the access hole, nor less than 3/4 in. (19 mm), nor does it need to…

37

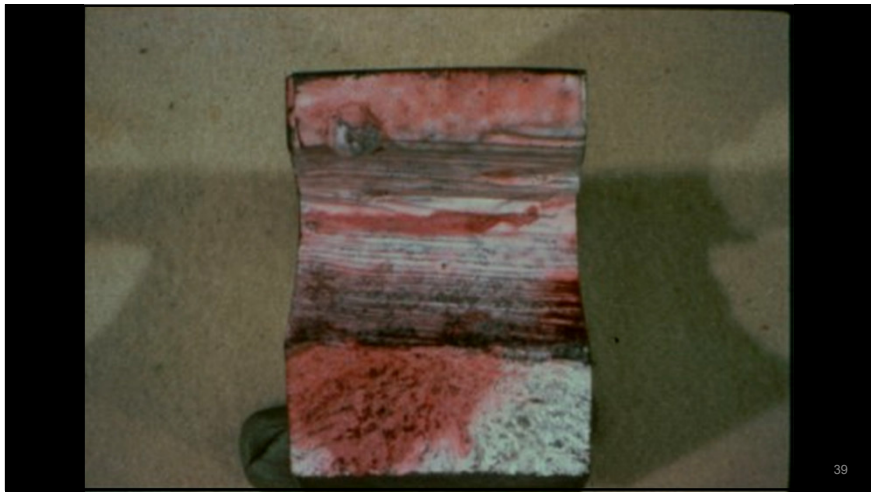
Details

$h_{minimum^*}$ = 1.0 t_w
> 3/4 in. (25 mm)
[need not exceed 2 in. (50 mm)]



$L_{minimum}$ = 1.5 t_w

38



39

AISC 360-16 Specification for Structural Steel Buildings

Workmanship

CHAPTER M
FABRICATION AND ERECTION

M2.2. Thermal Cutting

For beam copes and weld access holes in which the curved part of the access hole is thermally cut in ASTM A6/A6M hot-rolled shapes with a flange thickness exceeding 2 in. (50 mm) and welded built-up shapes with material thickness greater than 2 in. (50 mm), a preheat temperature of not less than 150°F (66°C) shall be applied prior to thermal cutting. The thermally cut surface of access holes in ASTM A6/A6M hot-rolled shapes with a flange thickness exceeding 2 in. (50 mm) and built-up shapes with a material thickness greater than 2 in. (50 mm) shall be ground.

40

AWS D1.1:2015 STRUCTURAL WELDING CODE

Table 3.3

Prequalified Minimum

Preheat/Interpass Temperatures

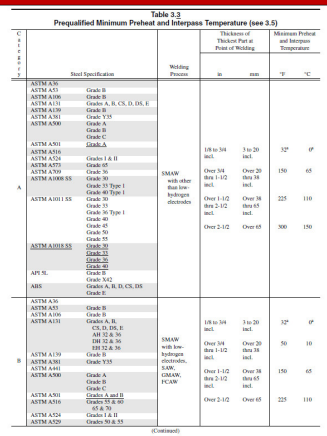


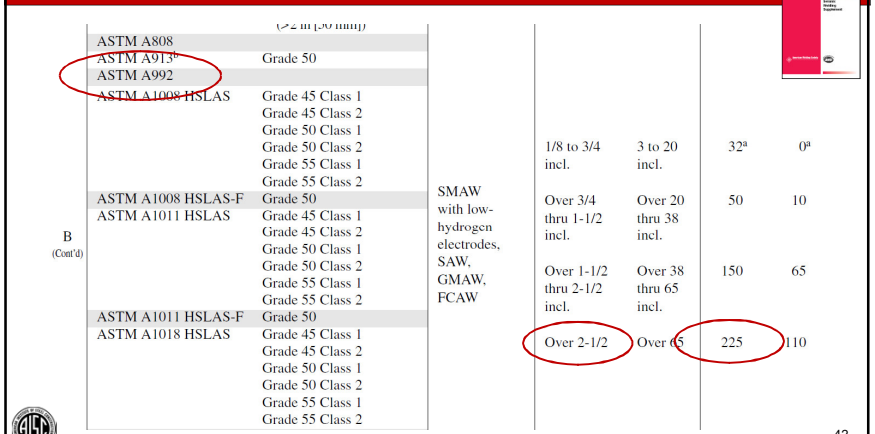
Table 3.3
Prequalified Minimum Preheat and Interpass Temperature (see 3.5)

Category	Steel Specification	Grade	Welding Process	Thickness of Thickest Part at Point of Welding, in	Thickness of Thickest Part at Point of Welding, mm	Minimum Preheat and Interpass Temperature, °F	Minimum Preheat and Interpass Temperature, °C
A	ASTM A36		SMAW with other than low-hydrogen electrodes	1/8 to 3/4 incl.	3 to 20 incl.	32[a]	0[a]
	ASTM A53	Grade B		Over 3/4 thru 1-1/2 incl.	Over 20 thru 38 incl.	150	65
	ASTM A106	Grade B		Over 1-1/2 thru 2-1/2 incl.	Over 38 thru 65 incl.	225	110
	ASTM A131	Grades A, B, CS, D, DS, E		Over 2-1/2	Over 65	300	150
	ASTM A139	Grade B					
	ASTM A381	Grade Y35					
	ASTM A500	Grade A Grade B Grade C					
	ASTM A501	Grade A					
	ASTM A516	Grades I A II					
	ASTM A524	Grade 65					
	ASTM A570	Grade 50					
	ASTM A1008 SS	Grade 30 Grade 33 Type 1 Grade 40 Type 1					
	ASTM A1011 SS	Grade 30 Grade 33 Grade 36 Type 1 Grade 40 Grade 45 Grade 50 Grade 55					
	ASTM A1018 SS	Grade 30 Grade 33 Grade 36 Grade 40					
	API 5L	Grade B Grade X42					
	ABS	Grades A, B, D, CS, DS Grade E					
B	ASTM A36		SMAW with low-hydrogen electrodes, SAW, GMAW, FCAW	1/8 to 3/4 incl.	3 to 20 incl.	32[a]	0[a]
	ASTM A53	Grade B		Over 3/4 thru 1-1/2 incl.	Over 20 thru 38 incl.	50	10
	ASTM A106	Grade B		Over 1-1/2 thru 2-1/2 incl.	Over 38 thru 65 incl.	150	65
	ASTM A131	Grades A, B, CS, D, DS, E AH 32 & 36 DH 32 & 36 EH 32 & 36		Over 2-1/2	Over 65	225	110
	ASTM A139	Grade B					
	ASTM A381	Grade Y35					
	ASTM A441	Grade A					
	ASTM A500	Grade A Grade B Grade C					
	ASTM A501	Grades A and B					
	ASTM A516	Grades 55 & 60 65 & 70					
	ASTM A524	Grades I A II					
	ASTM A529	Grades 50 & 55					

(Continued)

41

AWS D1.1:2015 STRUCTURAL WELDING CODE



	(>2 in [50 mm])				
B (Cont'd)	ASTM A808		SMAW with low-hydrogen electrodes, SAW, GMAW, FCAW		
	ASTM A913[b]	Grade 50			
	ASTM A992				
	ASTM A1008 HSLAS	Grade 45 Class 1			
		Grade 45 Class 2			
		Grade 50 Class 1			
		Grade 50 Class 2			
		Grade 55 Class 1			
		Grade 55 Class 2			
	ASTM A1008 HSLAS-F	Grade 50			
	ASTM A1011 HSLAS	Grade 45 Class 1			
		Grade 45 Class 2			
		Grade 50 Class 1			
		Grade 50 Class 2			
		Grade 55 Class 1			
		Grade 55 Class 2			
	ASTM A1011 HSLAS-F	Grade 50			
	ASTM A1018 HSLAS	Grade 45 Class 1			
		Grade 45 Class 2			
		Grade 50 Class 1			
		Grade 50 Class 2			
		Grade 55 Class 1			
		Grade 55 Class 2			

1/8 to 3/4 incl.	3 to 20 incl.	32[a]	0[a]
Over 3/4 thru 1-1/2 incl.	Over 20 thru 38 incl.	50	10
Over 1-1/2 thru 2-1/2 incl.	Over 38 thru 65 incl.	150	65
Over 2-1/2	Over 65	225	110

42

AISC 360-16 Specification for Structural Steel Buildings

Inspection

Commentary J1

J1.5. Splices in Heavy Sections

Previous editions of this Specification required magnetic particle or dye-penetrant inspection of thermally cut weld access holes for splices in heavy sections. This requirement was deliberately removed as anecdotal evidence suggested this inspection was not necessary because cracks from thermal cutting rarely occurred when the other Specification requirements were met. The previously prescribed magnetic particle testing or penetrant testing was replaced with a requirement for visual inspection of weld access holes after welding (see Table N5.4-3).

43

SPECIAL WELDING APPLICATIONS

Welding Heavy Sections: Summary

- Material notch toughness requirements (≥ 2 in [50 mm])
- Weld access hole geometry
- Preheat for thermal cutting, grinding
- MT and PT no longer required, but good visual needed
- Preheat for welding
- Follow other "good practices" for welding on highly restrained members

Material | Details | Workmanship | Inspection

44

SPECIAL WELDING APPLICATIONS

Today's Webinar

14.4 Welding on Heavy Shapes
14.6 Welding HSS
14.7 Welding AESS
14.8 Shop Versus Field Welding
14.9 Welding on Existing Structures
14.12 Cold Temperature Applications
14.15 Heat Shrinking
14.16 Buttering

45

SPECIAL WELDING APPLICATIONS

14.6 Welding HSS

- Connections and HSS member size
- Overall configuration
- Cutting and preparing HSS

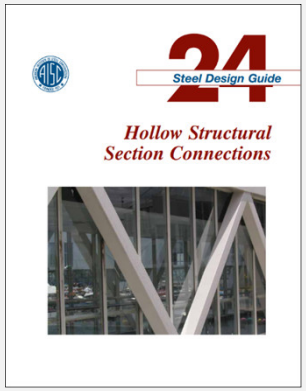
46

Design Guide 24

Hollow Structural Section Connections

by

Packer, Sherman, Lecce



47

Design Guide 24 Hollow Structural Section Connections

Chapter 1

Introduction

"Connections usually have been the challenging aspect for the designer of structures that involve HSS….Note that, in many cases, the local strength of the HSS at the connection is an integral part—and perhaps a limitation--of the design."

HSS member size may need to be increased to accommodate connection design.

48

Design Guide 24 Hollow Structural Section Connections

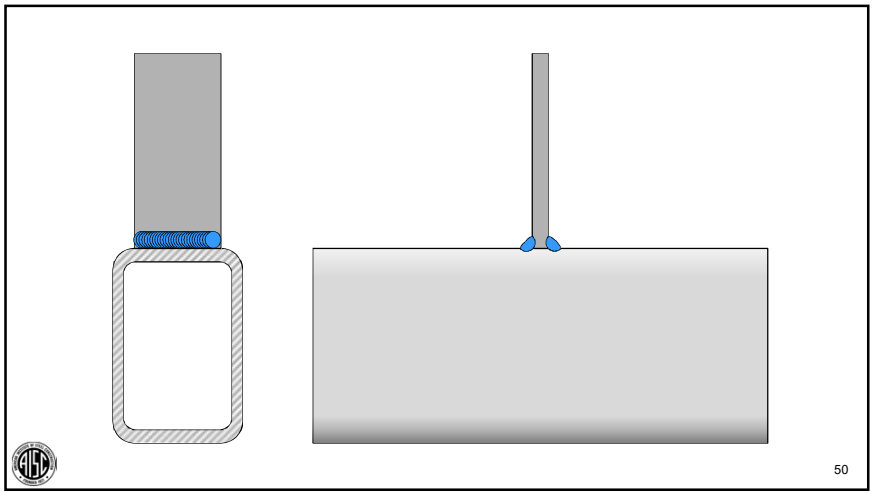
Chapter 2

Welding

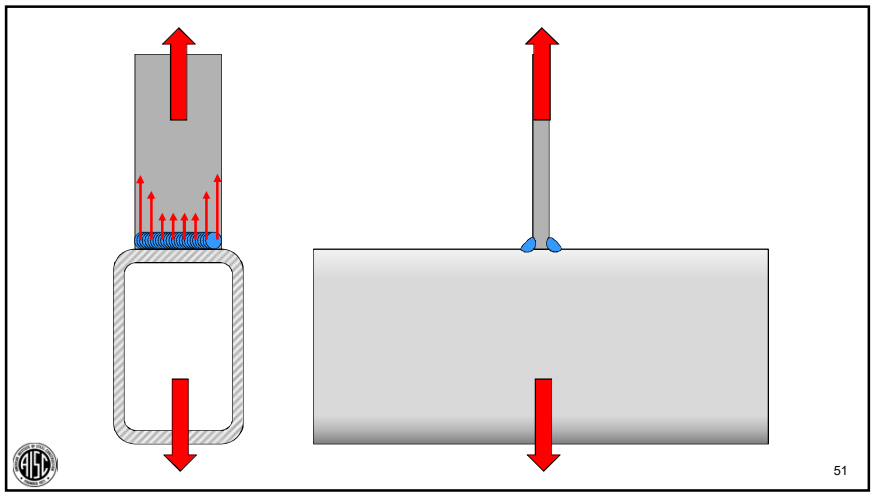
2.4 EFFECTIVE WELD LENGTH

Due to the variation in flexural stiffness of the wall across the width of a rectangular HSS, a force transmitted through a weld is often not uniformly distributed. This can be accounted for in design using an effective weld length approach. This reduced effective length applies both to the weld and to the force in the connected element.

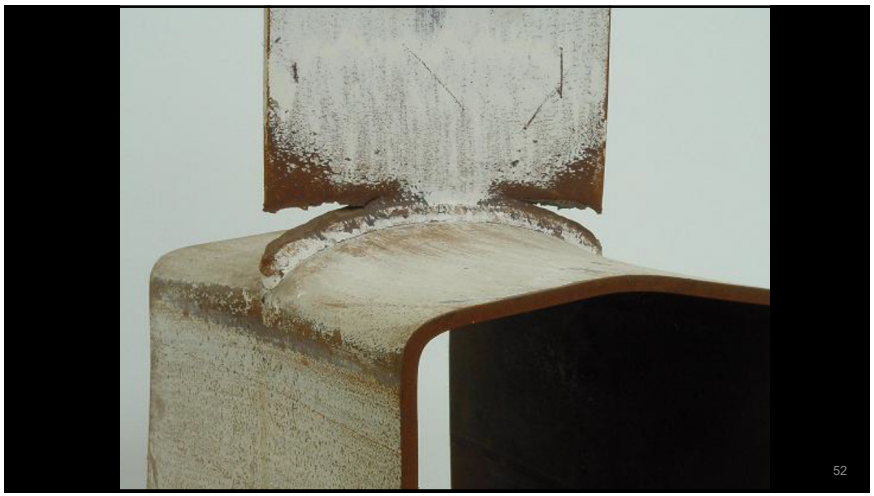
49



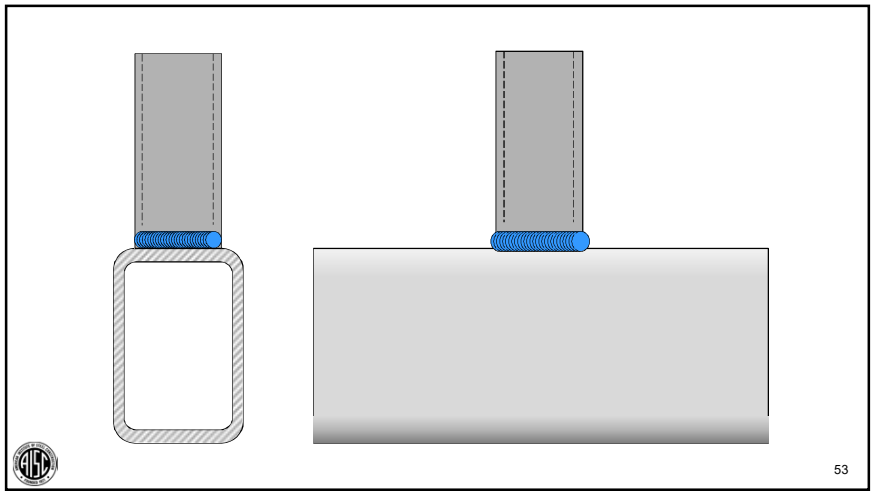
50



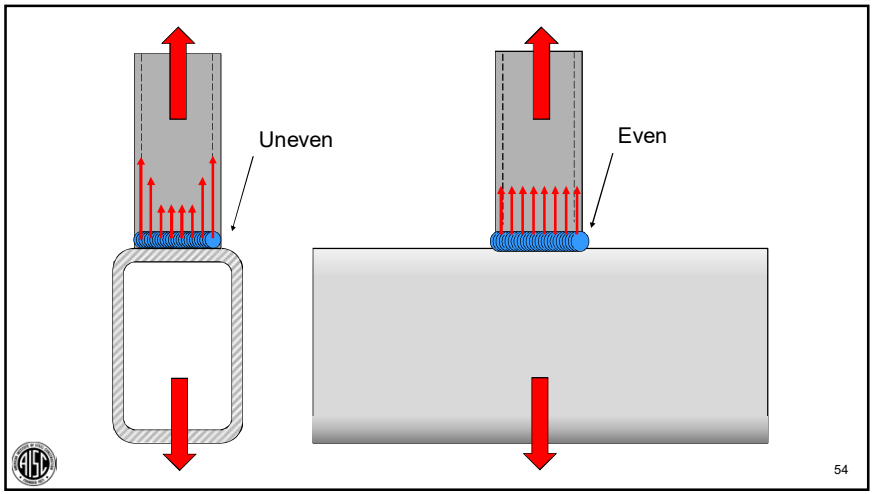
51



52



53



54

AISC 360:16 Specification for Structural Steel Buildings

TABLE K2.1

Available Strength of Plate-to-Round HSS Connections

TABLE K2.1
Available Strengths of Plate-to-Round HSS Connections

Connection Type	Connection Available Strength		Plate Bending
Transverse Plate T- and Cross-Connections	Limit State: HSS Local Yielding		
	Plate Axial Load	In-Plane	Out-of-Plane
	$R_n\sin\theta = F_y t^2\left(\frac{5.5}{1-0.81\frac{B_b}{D}}\right)Q_f$ (K2-1a)	–	$M_n = 0.5B_bR_n$ (K2-1b)
	$\phi = 0.90$ (LRFD)	$\Omega = 1.67$ (ASD)	
Longitudinal Plate T-, Y- and Cross-Connections	Limit State: HSS Plastification		
	Plate Axial Load	In-Plane	Out-of-Plane
	$R_n\sin\theta = 5.5F_y t^2\left(1+0.25\frac{l_b}{D}\right)Q_f$ (K2-2a)	$M_n = 0.8l_bR_n$ (K2-2b)	–
	$\phi = 0.90$ (LRFD)	$\Omega = 1.67$ (ASD)	
Functions			

$Q_f = 1$ for HSS (connecting surface) in tension
$= 1.0 - 0.3U(1+U)$ for HSS (connecting surface) in compression (K2-3)

$U = \left|\frac{P_{ro}}{F_cA_g} + \frac{M_{ro}}{F_cS}\right|$ (K2-4)

where P_{ro} and M_{ro} are determined on the side of the joint that has the lower compression stress. P_{ro} and M_{ro} refer to required strengths in the HSS: $P_{ro} = P_u$ for LRFD, and P_a for ASD; $M_{ro} = M_u$ for LRFD, and M_a for ASD.

55

AISC 360:16 Specification for Structural Steel Buildings

Longitudinal Plate T-, Y- and Cross-Connections

Limit State: HSS Plastification		
Plate Axial Load	In-Plane	Out-of-Plane
$R_n\sin\theta = 5.5F_y t^2\left(1+0.25\frac{l_b}{D}\right)Q_f$ (K2-2a)	$M_n = 0.8l_bR_n$ (K2-2b)	–
$\phi = 0.90$ (LRFD)	$\Omega = 1.67$ (ASD)	

56

AISC 360:16 Specification for Structural Steel Buildings

TABLE K5.1

Effective Weld Properties for Connection to Rectangular HSS

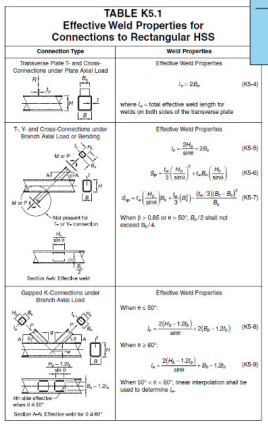


TABLE K5.1
Effective Weld Properties for Connections to Rectangular HSS

57

AISC 360:16 Specification for Structural Steel Buildings

TABLE K5.1
Effective Weld Properties for Connections to Rectangular HSS

Connection Type	Weld Properties
Transverse Plate T- and Cross-Connections under Plate Axial Load	Effective Weld Properties $l_e = 2B_e$ (K5-4) where l_e = total effective weld length for welds on both sides of the transverse plate

58

SPECIAL WELDING APPLICATIONS

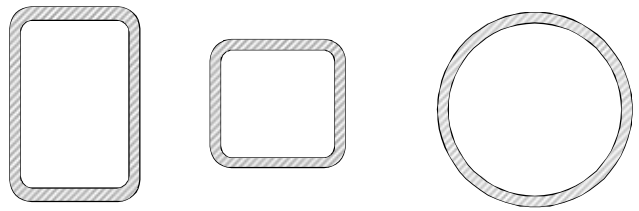
14.6 Welding HSS

- Connections and HSS member size
- Overall configuration
- Cutting and preparing HSS

59

SPECIAL WELDING APPLICATIONS

Rectangular **Round**

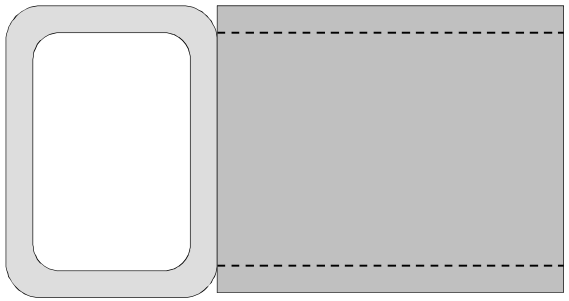


Rectangular is nearly always easier to fabricate

60

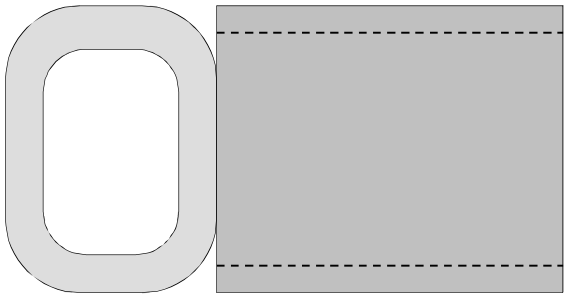
SPECIAL WELDING APPLICATIONS

Matched Connection



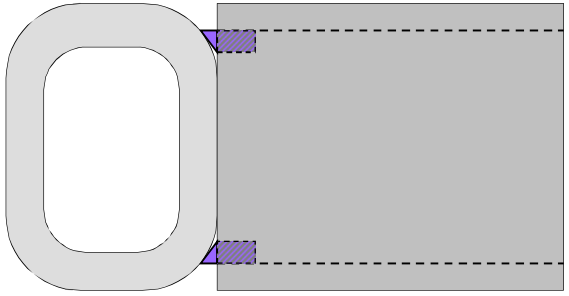
61

SPECIAL WELDING APPLICATIONS



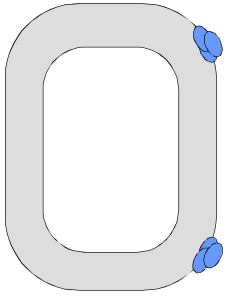
62

SPECIAL WELDING APPLICATIONS



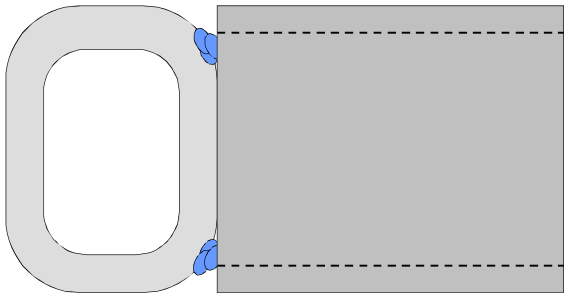
63

SPECIAL WELDING APPLICATIONS



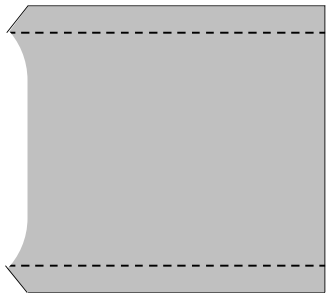
64

SPECIAL WELDING APPLICATIONS



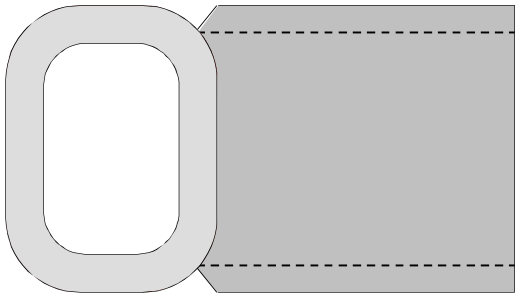
65

SPECIAL WELDING APPLICATIONS



66

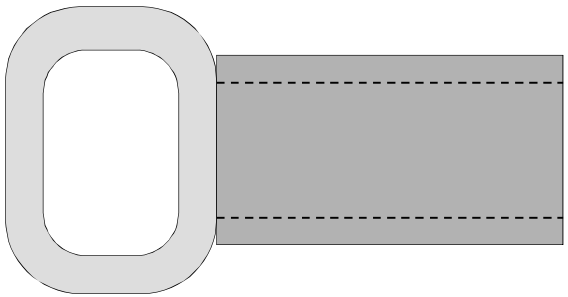
SPECIAL WELDING APPLICATIONS



67

SPECIAL WELDING APPLICATIONS

Stepped Connection



68

SPECIAL WELDING APPLICATIONS

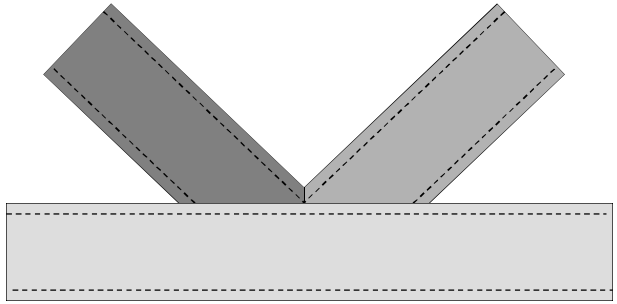
14.6 Welding HSS

- Connections and HSS member size
- Overall configuration
- Cutting and preparing HSS

69

SPECIAL WELDING APPLICATIONS

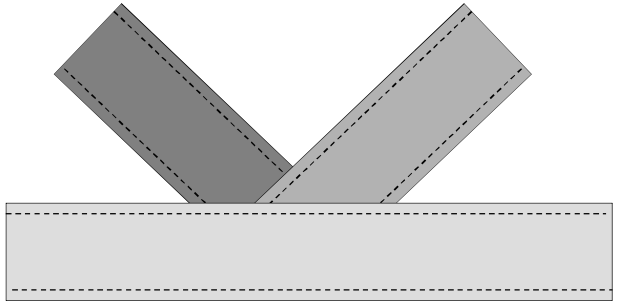
Overlapped



70

SPECIAL WELDING APPLICATIONS

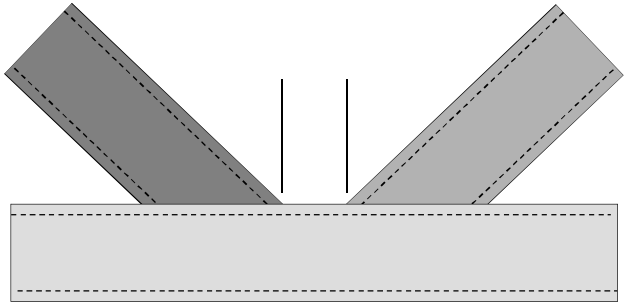
Overlapped



71

SPECIAL WELDING APPLICATIONS

Gapped



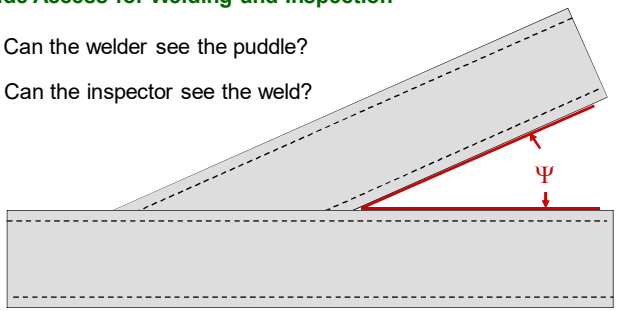
Preferred

72

SPECIAL WELDING APPLICATIONS

Provide Access for Welding and Inspection

- Can the welder see the puddle?
- Can the inspector see the weld?



Ψ = 30° minimum

73

SPECIAL WELDING APPLICATIONS

14.6 Welding HSS

- Connections and HSS member size
- Overall configuration
- Cutting and preparing HSS

74

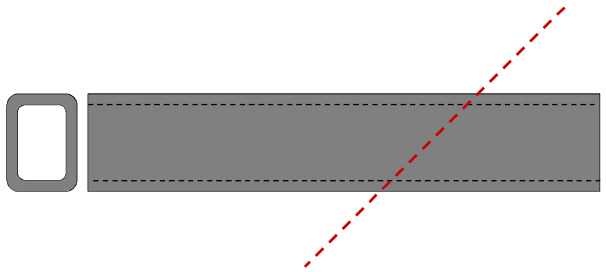
SPECIAL WELDING APPLICATIONS

Box HSS

75

SPECIAL WELDING APPLICATIONS

Box HSS



76

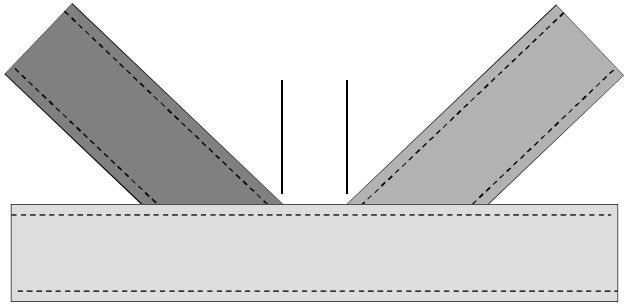
SPECIAL WELDING APPLICATIONS

Box HSS

77

SPECIAL WELDING APPLICATIONS

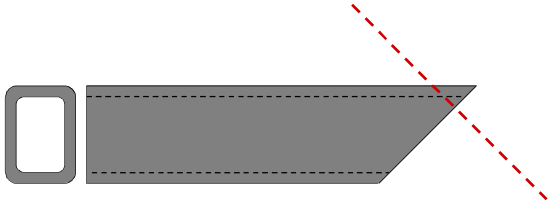
Gapped



78

SPECIAL WELDING APPLICATIONS

Box HSS



79

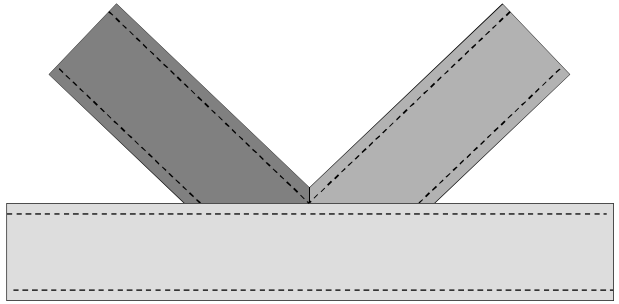
SPECIAL WELDING APPLICATIONS

Box HSS

80

SPECIAL WELDING APPLICATIONS

Overlapped



81

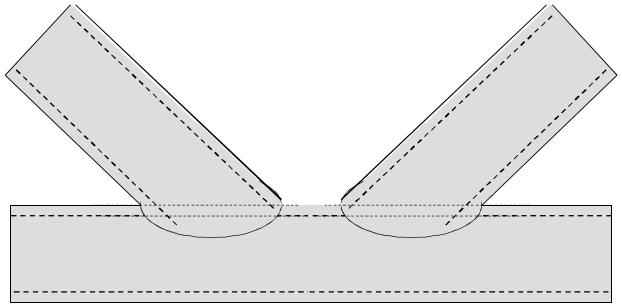
SPECIAL WELDING APPLICATIONS

Round HSS

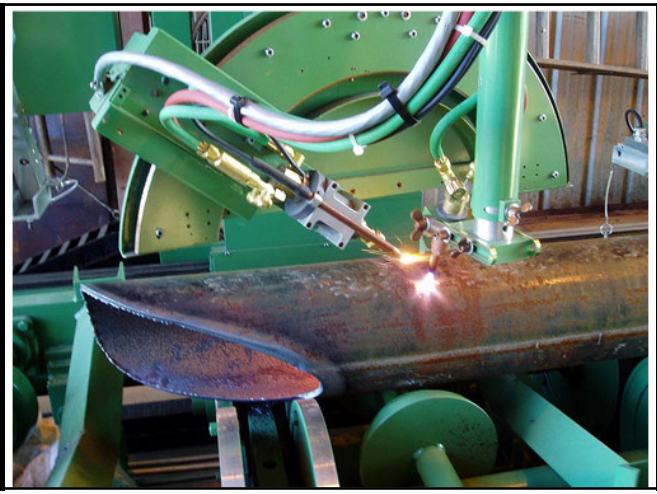
82

SPECIAL WELDING APPLICATIONS

Round HSS



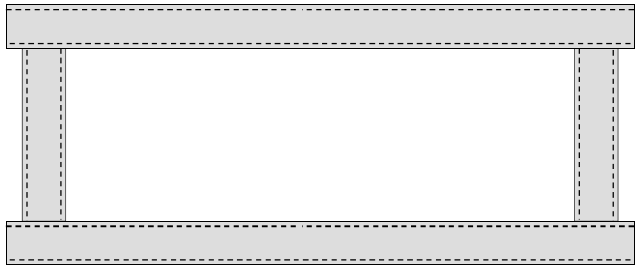
83



84

SPECIAL WELDING APPLICATIONS

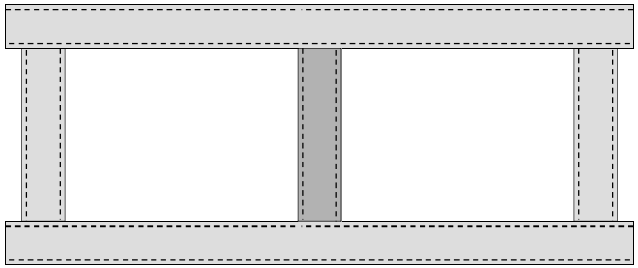
Box HSS



85

SPECIAL WELDING APPLICATIONS

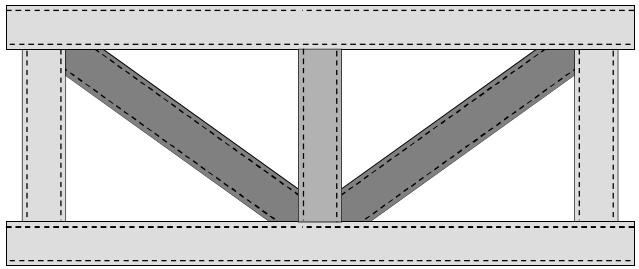
Box HSS



86

SPECIAL WELDING APPLICATIONS

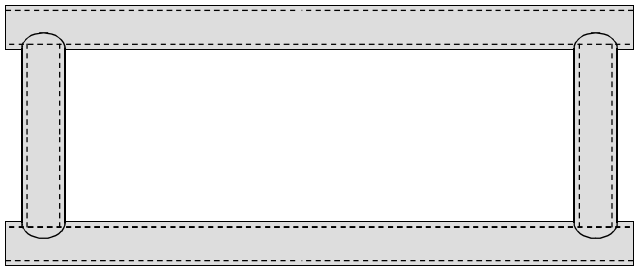
Box HSS



87

SPECIAL WELDING APPLICATIONS

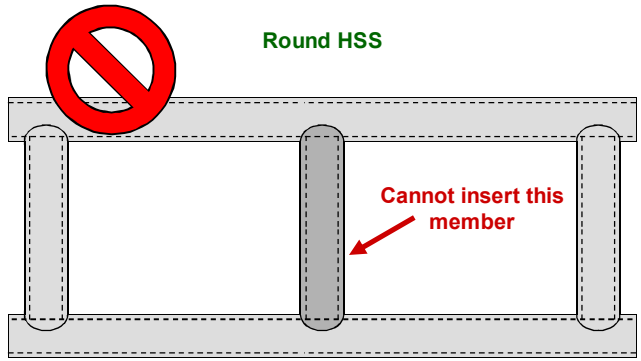
Round HSS



88

SPECIAL WELDING APPLICATIONS

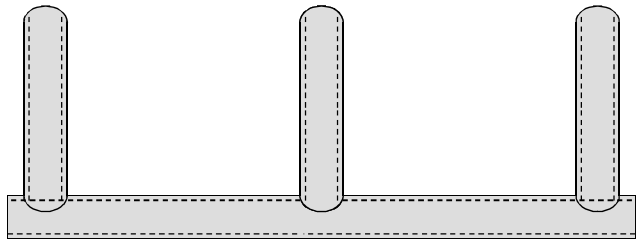
Round HSS



89

SPECIAL WELDING APPLICATIONS

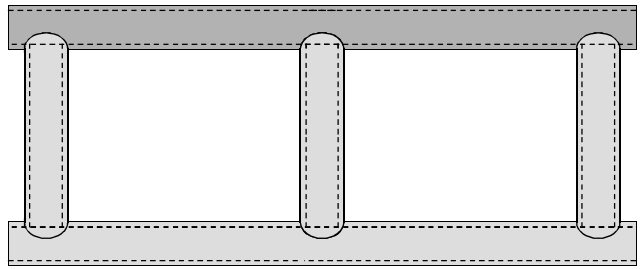
Round HSS



90

SPECIAL WELDING APPLICATIONS

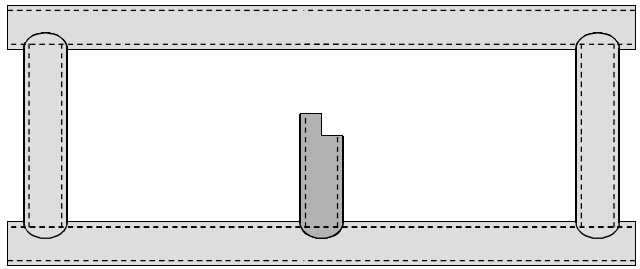
Round HSS



91

SPECIAL WELDING APPLICATIONS

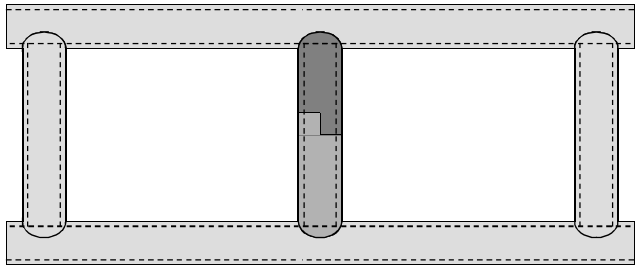
Round HSS



92

SPECIAL WELDING APPLICATIONS

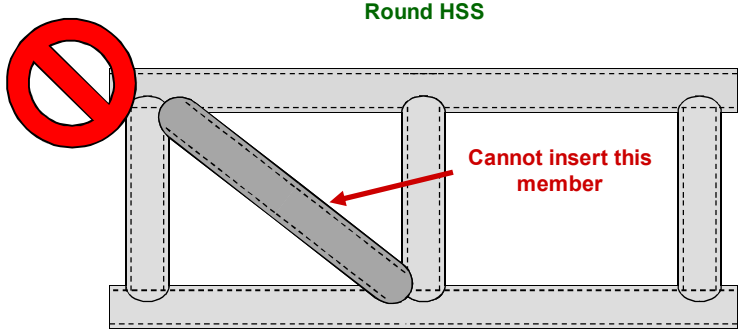
Round HSS



93

SPECIAL WELDING APPLICATIONS

Round HSS



94

AWS D1.1:2015 STRUCTURAL WELDING CODE

9. Tubular Structures

9.1 General

This Clause supplements Clauses 1–8. The specific requirements of Clause 9 apply only to tubular connections. For design purposes this clause shall be used with the applicable requirements of Clause 2, Part A. All provisions of Clause 9 apply to static applications and cyclic applications, with the exception of the fatigue provisions of 9.2.7, which are unique to cyclic applications.

This clause is divided into parts, as follows:

Part A — **Design of Tubular Connections**
Part B — **Prequalification of Welding Procedure Specifications (WPSs)**
Part C — **Welding Procedure Specification (WPS) Qualification**
Part D — **Performance Qualification**
Part E — **Fabrication**

9.2.3 Tubular Section Limitations. Limitations on diameter/thickness for circular sections, and largest flat width/thickness ratio for box sections, beyond which local buckling or other local failure modes shall be considered, shall be in conformance with the governing design code. Limits of applicability for the criteria given in 9.6 shall be observed as follows:

(1) Circular tubes: $D/t < 3300/F_y$ [for F_y in ksi], $22\,800/F_y$ (for F_y in MPa)

(2) Box section gap connections: $D/t \le 210/\sqrt{F_y}$ [for F_y in ksi], $550/\sqrt{F_y}$ (for F_y in MPa) but not more than 35

(3) Box section overlap connections: $D/t \le 190/\sqrt{F_y}$ [for F_y in ksi], $500/\sqrt{F_y}$ (for F_y in MPa)

9.2.4 Welds Stresses. The allowable stresses in welds shall not exceed those given in Table 9.2, or as allowed

95

SPECIAL WELDING APPLICATIONS

Welding HSS: Summary

- Welds are usually unevenly stressed
- Connection details may control member sizes
- Round vs square/rectangular: box tubes usually easier
- Cutting and assembly
- Access for welding and inspection
- May also have AESS concerns

96

SPECIAL WELDING APPLICATIONS

Today's Webinar

14.4 Welding on Heavy Shapes
14.6 Welding HSS
14.7 Welding AESS
14.8 Shop Versus Field Welding
14.9 Welding on Existing Structures
14.12 Cold Temperature Applications
14.15 Heat Shrinking
14.16 Buttering

97

98

99

100

SPECIAL WELDING APPLICATIONS

Welding AESS

- Defining “pretty”
- Use of Mock-ups
- Technical issues
- Note requirements on drawings

104

AISC 303-16 Code of Standard Practice for Steel Buildings and Bridges

AISC 303-16

Code of Standard Practice for Steel Buildings and Bridges

Section 10.

Architecturally Exposed Structural Steel

TABLE 10.1
AESS Category Matrix

Id	Characteristics	AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements in close view	AESS 2 Feature Elements not in close view	AESS 1 Basic Elements	SSS Standard Structural Steel
1.1	Surface preparation to SSPC-SP 6		•	•	•	•	
1.2	Sharp edges ground smooth		•	•	•	•	
1.3	Continuous weld appearance		•	•	•	•	
1.4	Standard structural bolts		•	•	•	•	
1.5	Weld spatters removed		•	•	•	•	
2.1	Visual samples		•	•	optional		
2.2	One-half standard fabrication tolerances		•	•	•		
2.3	Fabrication marks not apparent		•	•	•		
2.4	Welds uniform and smooth		•	•	•		
3.1	Mill marks removed		•	•			
3.2	Butt and plug welds ground smooth and filled		•	•			
3.3	HSS weld seam oriented for reduced visibility		•	•			
3.4	Cross sectional abutting surface aligned		•	•			
3.5	Joint gap tolerances minimized		•	•			
3.6	All welded connections		optional	optional			
4.1	HSS seam not apparent		•				
4.2	Welds contoured and blended		•				
4.3	Surfaces filed and sanded		•				
4.4	Weld show-through minimized		•				
C.1							
C.2							
C.3							
C.4							
C.5							

User Note:
1.1 Prior to blast cleaning, grease and oil are removed by solvent cleaning to meet SSPC-SP1.
1.2 Rough surfaces are deburred and ground smooth. Sharp edges resulting from flame cutting, grinding and especially shearing are softened.
1.3 Intermittent welds are made continuous, either with additional welding, caulking or body filler. For corrosive environ-

105

AISC 303-16 Code of Standard Practice for Steel Buildings and Bridges

TABLE 10.1
AESS Category Matrix

Id	Characteristics	AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements in close view	AESS 2 Feature Elements not in close view	AESS 1 Basic Elements	SSS Standard Structural Steel
1.1	Surface preparation to SSPC-SP 6		•	•	•	•	
1.2	Sharp edges ground smooth		•	•	•	•	
1.3	Continuous weld appearance		•	•	•	•	
1.4	Standard structural bolts		•	•	•	•	
1.5	Weld spatters removed		•	•	•	•	
2.1	Visual samples		•	•	optional		
2.2	One-half standard fabrication tolerances		•	•	•		
2.3	Fabrication marks not apparent		•	•	•		
2.4	Welds uniform and smooth		•	•	•		
3.1	Mill marks removed		•	•			
3.2	Butt and plug welds ground smooth and filled		•	•			
3.3	HSS weld seam oriented for reduced visibility		•	•			
3.4	Cross sectional abutting surface aligned		•	•			
3.5	Joint gap tolerances minimized		•	•			
3.6	All welded connections		optional	optional			
4.1	HSS seam not apparent		•				
4.2	Welds contoured and blended		•				
4.3	Surfaces filed and sanded		•				
4.4	Weld show-through minimized		•				
C.1							
C.2							
C.3							
C.4							
C.5							

106

AISC 303-16 Code of Standard Practice for Steel Buildings and Bridges

TABLE 10.1
AESS Category Matrix

Id	Characteristics	AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements in close view	AESS 2 Feature Elements not in close view	AESS 1 Basic Elements	SSS Standard Structural Steel
1.1	Surface preparation to SSPC-SP 6		•	•	•	•	
1.2	Sharp edges ground smooth		•	•	•	•	
1.3	Continuous weld appearance		•	•	•	•	
1.4	Standard structural bolts		•	•	•	•	
1.5	Weld spatters removed		•	•	•	•	
2.1	Visual samples		•	•	optional		
2.2	One-half standard fabrication tolerances		•	•	•		
2.3	Fabrication marks not apparent		•	•	•		
2.4	Welds uniform and smooth		•	•	•		

107

AISC 303-16 Code of Standard Practice for Steel Buildings and Bridges

TABLE 10.1
AESS Category Matrix

Id	Characteristics	AESS C Custom Elements	AESS 4 Showcase Elements	AESS 3 Feature Elements in close view	AESS 2 Feature Elements not in close view	AESS 1 Basic Elements	SSS Standard Structural Steel
1.1	Surface preparation to SSPC-SP 6		•	•	•	•	
1.2	Sharp edges ground smooth		•	•	•	•	
1.3	Continuous weld appearance		•	•	•	•	
1.4	Standard structural bolts		•	•	•	•	
1.5	Weld spatters removed		•	•	•	•	
2.1	Visual samples		•	•	optional		
2.2	One-half standard fabrication tolerances		•	•	•		
2.3	Fabrication marks not apparent		•	•	•		
2.4	Welds uniform and smooth		•	•	•		

108

AISC 303-16 Code of Standard Practice for Steel Buildings and Bridges

1.1	Surface preparation to SSPC-SP 6		•	•	•	•
1.2	Sharp edges ground smooth		•	•	•	•
1.3	Continuous weld apprearance		•	•	•	•
1.4	Standard structural bolts		•	•	•	•
1.5	Weld spatters removed		•	•	•	•
2.1	Visual samples		•	•	optional	
2.2	One-half standard fabrication tolerances		•	•	•	
2.3	Fabrication marks not apparent		•	•	•	
2.4	Welds uniform and smooth		•	•	•	
3.1	Mill marks removed		•	•		
3.2	Butt and plug welds ground smooth and filled		•	•		
3.3	HSS weld seam oriented for reduced visibility		•	•		
3.4	Cross sectional abutting surface aligned		•	•		
3.5	Joint gap tolerances minimized		•	•		
3.6	All welded connections		optional	optional		
4.1	HSS seam not apparent		•			
4.2	Welds contoured and blended		•			
4.3	Surfaces filed and sanded		•			
4.4	Weld show-through minimized		•			

Many welding-related issues

109

SPECIAL WELDING APPLICATIONS

Welding AESS

- Defining “pretty”
- Use of Mock-ups
- Technical issues
- Note requirements on drawings

110

AISC 303-16 Code of Standard Practice for Steel Buildings and Bridges

1.1	Surface preparation to SSPC-SP 6		•	•	•	•
1.2	Sharp edges ground smooth		•	•	•	•
1.3	Continuous weld apprearance		•	•	•	•
1.4	Standard structural bolts		•	•	•	•
1.5	Weld spatters removed		•	•	•	•
2.1	Visual samples		•	•	optional	
2.2	One-half standard fabrication tolerances		•	•	•	
2.3	Fabrication marks not apparent		•	•	•	
2.4	Welds uniform and smooth		•	•	•	
3.1	Mill marks removed		•	•		
3.2	Butt and plug welds ground smooth and filled		•	•		
3.3	HSS weld seam oriented for reduced visibility		•	•		
3.4	Cross sectional abutting surface aligned		•	•		
3.5	Joint gap tolerances minimized		•	•		
3.6	All welded connections		optional	optional		
4.1	HSS seam not apparent		•			
4.2	Welds contoured and blended		•			
4.3	Surfaces filed and sanded		•			
4.4	Weld show-through minimized		•			

Mock-ups

111

AISC 303-16 Code of Standard Practice for Steel Buildings and Bridges

SECTION 10. ARCHITECTURALLY EXPOSED STRUCTURAL STEEL

10.1.2. A mock-up shall be required for AESS 3, 4 and C. If a mock-up is to be used in other *AESS* categories, it shall be specified in the *contract documents*. When required, the nature and extent of the mock-up shall be specified in the *contract documents*. Alternatively, when a mock-up is not practical, the first piece of an element or *connection* can be used to determine acceptability.

112

AISC 303-16 Code of Standard Practice for Steel Buildings and Bridges

SECTION 10. ARCHITECTURALLY EXPOSED STRUCTURAL STEEL

Commentary:

Generally, a mock-up is produced and approved in the shop and subsequently placed in the field. The acceptability of the mock-up can be affected by many factors, including distance of view, lighting and finishing. The expectations for the location and conditions of the mock-up at time of approval should be defined in the *contract documents*.

Suggestion: View mock-up at the same distance as the viewer will be from the final welded connection in service.

113

SPECIAL WELDING APPLICATIONS

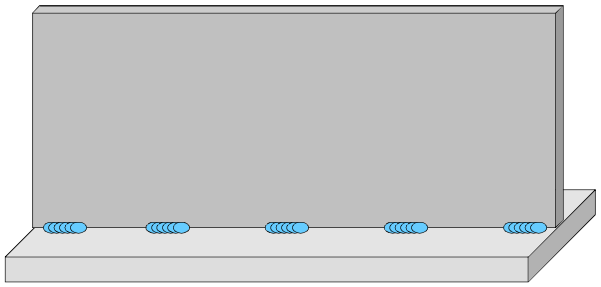
Welding AESS

- Defining "pretty"
- Use of Mock-ups
- Technical issues
- Note requirements on drawings

114

SPECIAL WELDING APPLICATIONS

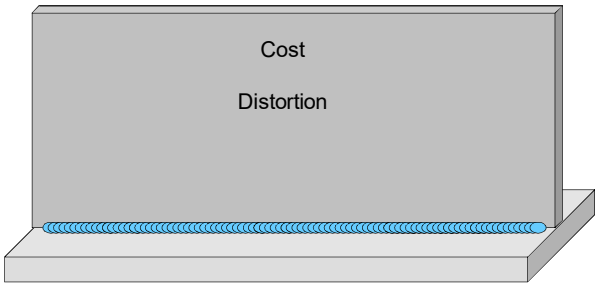
Sufficient for strength



115

SPECIAL WELDING APPLICATIONS

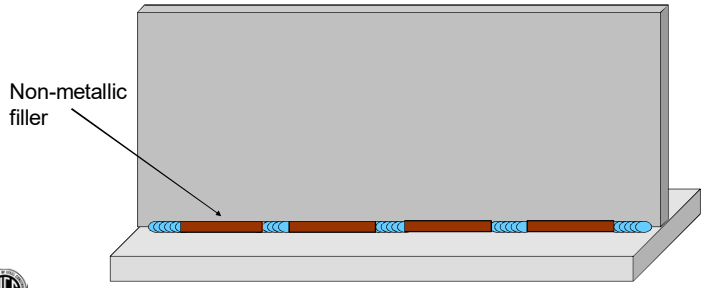
May be required for AESS



116

SPECIAL WELDING APPLICATIONS

Sufficient for strength

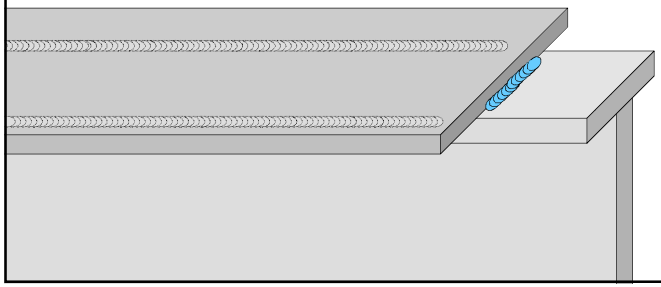


117

SPECIAL WELDING APPLICATIONS

D1.1 code required practice*

*modified in 2015 edition



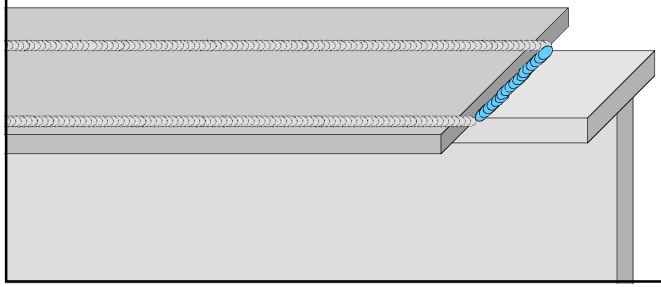
118

SPECIAL WELDING APPLICATIONS

May be AESS specified practice

Workmanship Concerns

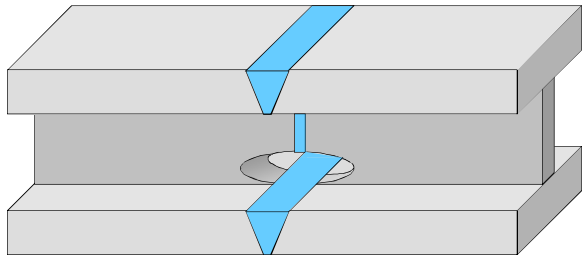
Inspection Concerns



119

SPECIAL WELDING APPLICATIONS

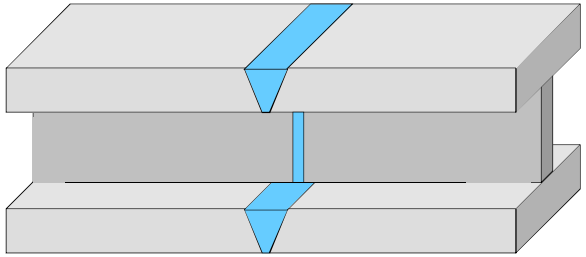
Code required practice



120

SPECIAL WELDING APPLICATIONS

May be AESS specified practice

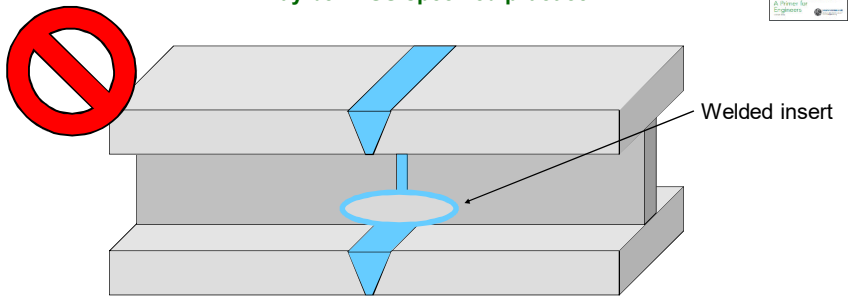


How can flange CJP groove weld be made?

121

SPECIAL WELDING APPLICATIONS

May be AESS specified practice

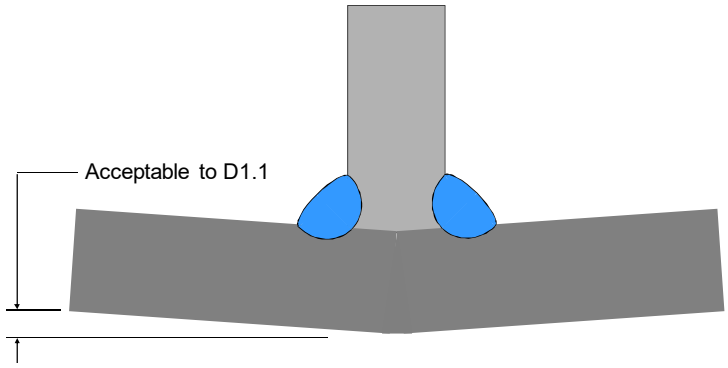


Will splice crack when insert is welded?

122

SPECIAL WELDING APPLICATIONS

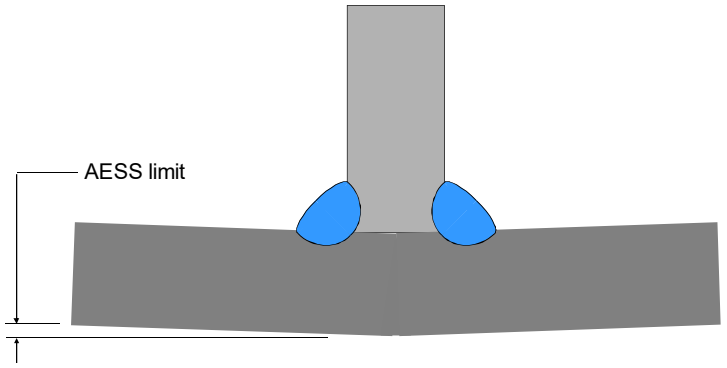
Distortion



123

SPECIAL WELDING APPLICATIONS

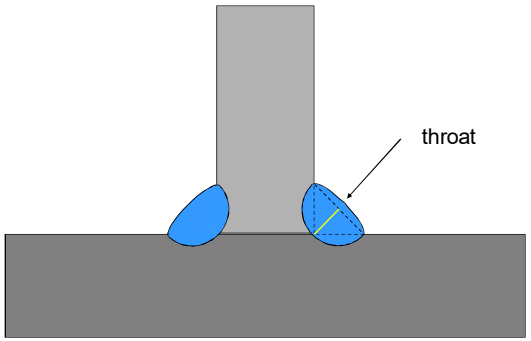
Distortion



124

SPECIAL WELDING APPLICATIONS

Weld Throats

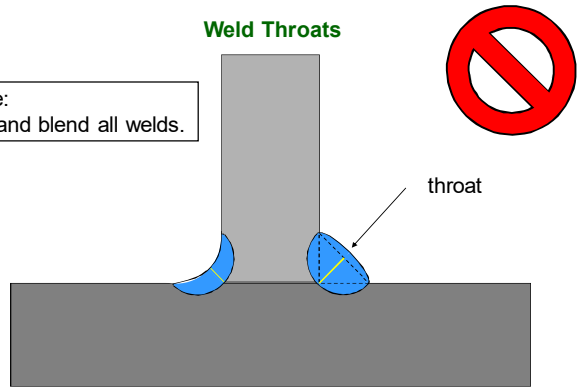


125

SPECIAL WELDING APPLICATIONS

Weld Throats

Project note:
1. Contour and blend all welds.



126

127

SPECIAL WELDING APPLICATIONS

Welding AESS

- Defining “pretty”
- Use of Mock-ups
- Technical issues
- Note requirements on drawings

128

SPECIAL WELDING APPLICATIONS

Welding AESS: Summary

- Defining “pretty”; use AISC 303 Section 10
- Mock-ups are often critical; view from an appropriate distance
- Define all expectations; some requirement may conflict with code requirements

129

SPECIAL WELDING APPLICATIONS

Today’s Webinar

14.4 Welding on Heavy Shapes
14.6 Welding HSS
14.7 Welding AESS
14.8 Shop Versus Field Welding
14.9 Welding on Existing Structures
14.12 Cold Temperature Applications
14.15 Heat Shrinking
14.16 Buttering

130

131

132

SPECIAL WELDING APPLICATIONS

Shop versus Field Welding

- Primarily an issue of cost
- Some environmental issues (cold, wind, rain, etc.)
- Out-of-positon welding may be needed
- Easier to control projects in a shop environment

133

SPECIAL WELDING APPLICATIONS

Myths

- You can't get quality welds out-of-positon

134

AWS D1.1:2015 STRUCTURAL WELDING CODE

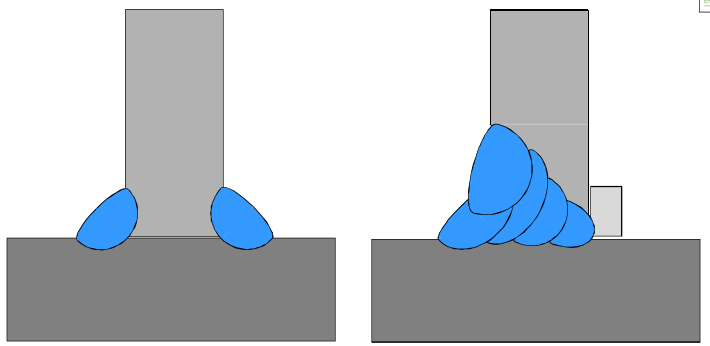
Table 4.12
Welding Personnel Performance Essential Variable Changes Requiring Requalification (see 4.19)

Essential Variable Changes to WPQR Requiring Requalification	Welding Personnel		
	Welders[b]	Welding Operators[b,c]	Tack Welders
(1) To a process not qualified (GMAW-S is considered a separate process)	X	X	X
(2) To an SMAW electrode with an F-number (see Table 4.13) higher than the WPQR electrode F-number	X		X
(3) To a position not qualified	X	X	X
(4) To a diameter or thickness not qualified	X	X	
(5) To a vertical welding progression not qualified (uphill or downhill)	X		
(6) The omission of backing (if used in the WPQR test)	X	X	
(7) To multiple electrodes (if a single electrode was used in the WPQR test) but not vice versa		X[a]	

135

SPECIAL WELDING APPLICATIONS

Usually Preferred

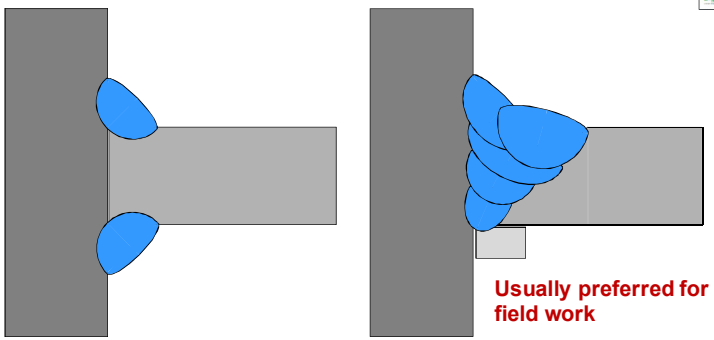


136

SPECIAL WELDING APPLICATIONS

Requires overhead welding

All flat welding



Usually preferred for field work

137

SPECIAL WELDING APPLICATIONS

Myths

- You can't get quality welds out-of-positon
- You can't get quality in the field
- Codes do not apply to field welding

138

AWS D1.1:2015 STRUCTURAL WELDING CODE

5. Fabrication

5.1 Scope

All applicable provisions of this section shall be observed in the fabrication and erection of welded assemblies and structures produced by any process acceptable under this code (see 3.2 and 4.13).

5.2 Base Metal

5.2.1 Specified Base Metal. The contract documents shall designate the specification and classification of base metal to be used. When welding is involved in the structure, approved base metals, listed in Table 3.1 or Table 4.9, should be used wherever possible.

5.3 Welding Consumables and Electrode Requirements

5.3.1 General

5.3.1.1 Certification for Electrodes or Electrode-Flux Combinations. When requested by the Engineer, the Contractor or fabricator shall furnish certification that the electrode or electrode-flux combination conforms to the requirements of the classification.

5.3.1.2 Suitability of Classification. The classification and size of electrode, arc length, voltage, and amperage shall be suited to the thickness of the material, type of groove, welding positions, and other circumstances attending the work. Welding current shall be within the range recommended by the electrode manufacturer.

139

AWS D1.1:2015 STRUCTURAL WELDING CODE

5.1 Scope

All applicable provisions of this section shall be observed in the fabrication and erection of welded assemblies and structures produced by any process acceptable under this code (see 3.2 and 4.14).

140

SPECIAL WELDING APPLICATIONS

Myths

- You can't get quality welds out-of-positon
- You can't get quality in the field
- Codes do not apply to field welding
- Field welders are not "certified" (qualified)
- WPSs are not used in the field
- There is no audit program for field contractors

141


American Institute of Steel Construction, Inc.

is proud to recognize

ABC Erectors, Inc.

Any City, USA

for successfully meeting the quality certification requirements for

Advanced Certified Steel Erector

Roger E. Ferch

Bobbi Mancellar

Certification valid through May 2006

142

SPECIAL WELDING APPLICATIONS

Myths

- You can't get quality welds out-of-positon
- You can't get quality in the field
- Codes do not apply to field welding
- Field welders are not "certified" (qualified)
- WPSs are not used in the field
- There is no audit program for field contractors
- There are no contractor-supplied inspectors for field work

143

AISC 360-16 Specification for Structural Steel Buildings

CHAPTER N

QUALITY CONTROL AND QUALITY ASSURANCE

N1. GENERAL PROVISIONS

Quality control (QC) as specified in this chapter shall be provided by the fabricator and erector. Quality assurance (QA) as specified in this chapter shall be provided by others when required by the authority having jurisdiction (AHJ), applicable building code, purchaser, owner, or engineer of record (EOR). Nondestructive testing (NDT) shall be performed by the agency or firm responsible for quality assurance, except as permitted in accordance with Section N6.

144

AISC 360-16 Specification for Structural Steel Buildings

CHAPTER N

QUALITY CONTROL AND QUALITY ASSURANCE

N2. FABRICATOR AND ERECTOR QUALITY CONTROL PROGRAM

The fabricator and erector shall establish, maintain and implement QC procedures to ensure that their work is performed in accordance with this Specification and the construction documents.

SPECIAL WELDING APPLICATIONS

Shop vs Field Welding: Summary

- There are some legitimate differences/concerns
- Shop operations generally preferred due to lower costs
- Mature codes control field welding
- Field contractor certification programs exist
- Inspection requirements have been made clearer in Chapter N

SPECIAL WELDING APPLICATIONS

Today's Webinar

14.4 Welding on Heavy Shapes
14.6 Welding HSS
14.7 Welding AESS
14.8 Shop Versus Field Welding
14.9 Welding on Existing Structures
14.12 Cold Temperature Applications
14.15 Heat Shrinking
14.16 Buttering

SPECIAL WELDING APPLICATIONS

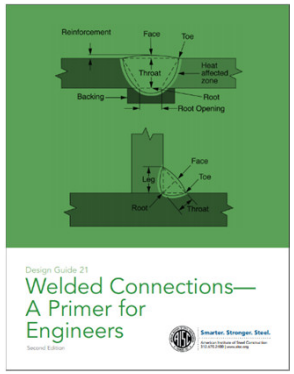
14.9 Welding on Existing Structures

- Historic steels
- Welding under load
- Fire
- Cold working / strain aging

AISC Design Guide 21

Chapter 4 Metallurgical Issues

- Historic (obsolete) steels
  - ASTM A9
  - ASTM A7
  - ASTM A373
  - ASTM A242
- Check weldability of steel (especially if riveted)



149

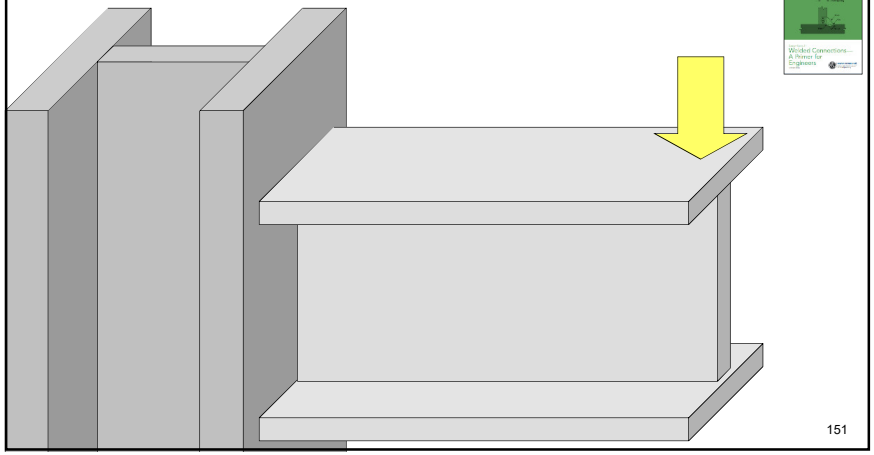
SPECIAL WELDING APPLICATIONS

14.9 Welding on Existing Structures

- Historic steels
- Welding under load
- Fire
- Cold working / strain aging

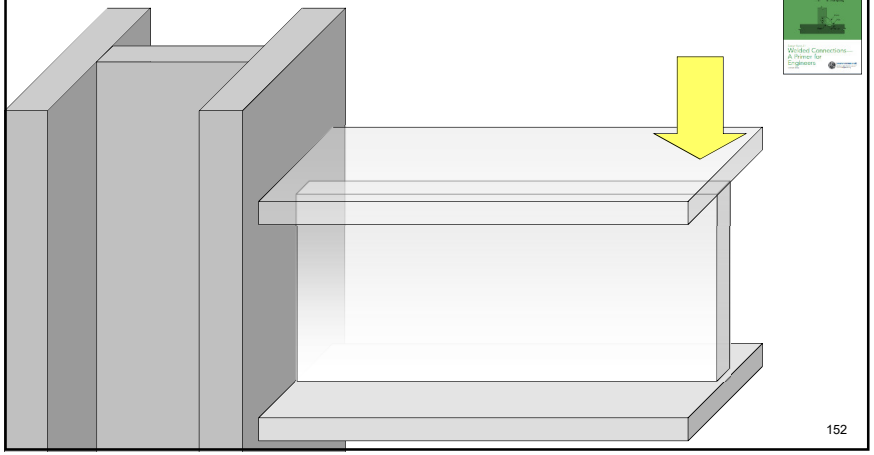
150

SPECIAL WELDING APPLICATIONS

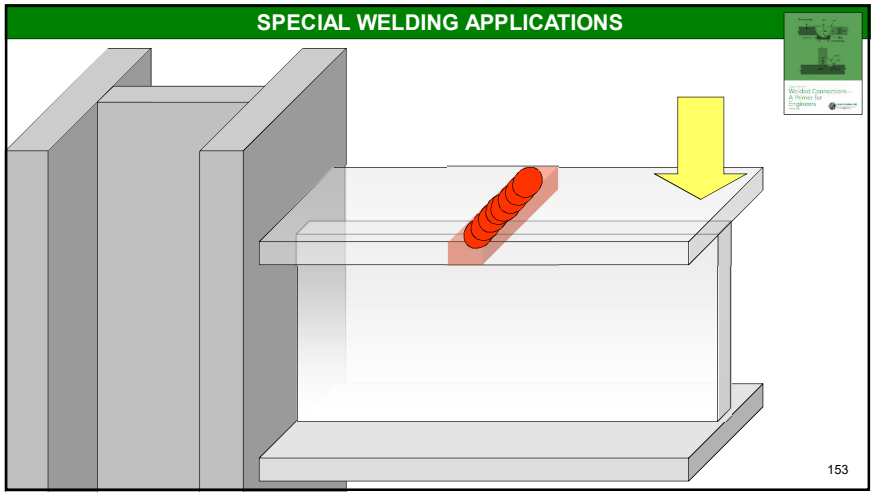


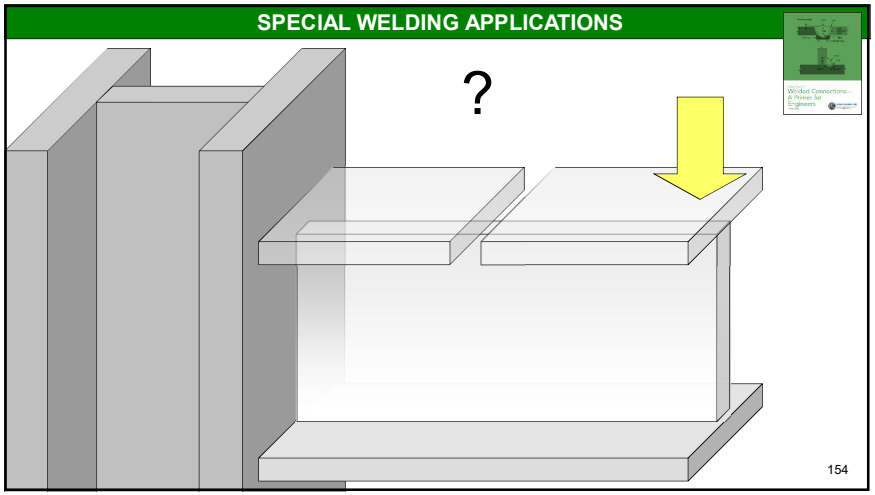
151

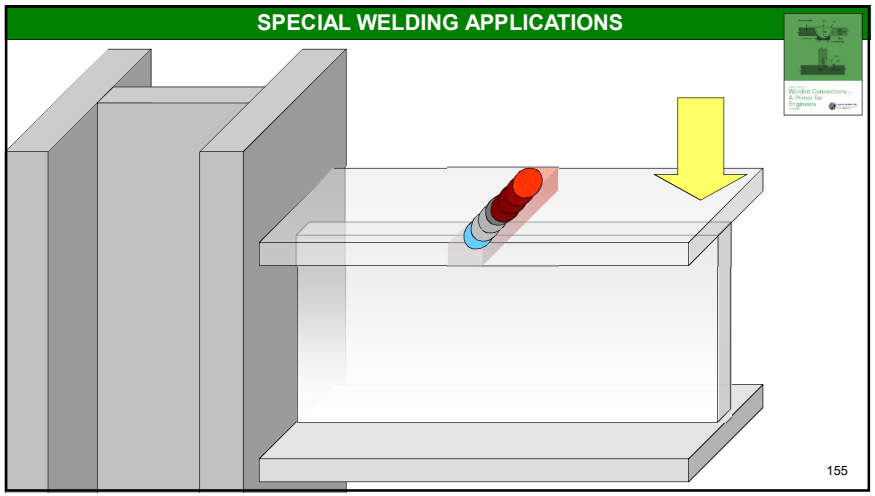
SPECIAL WELDING APPLICATIONS

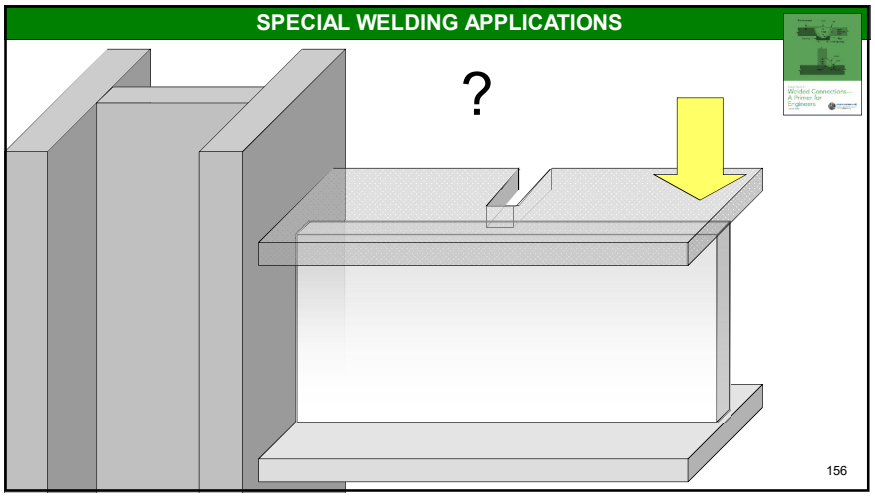


152

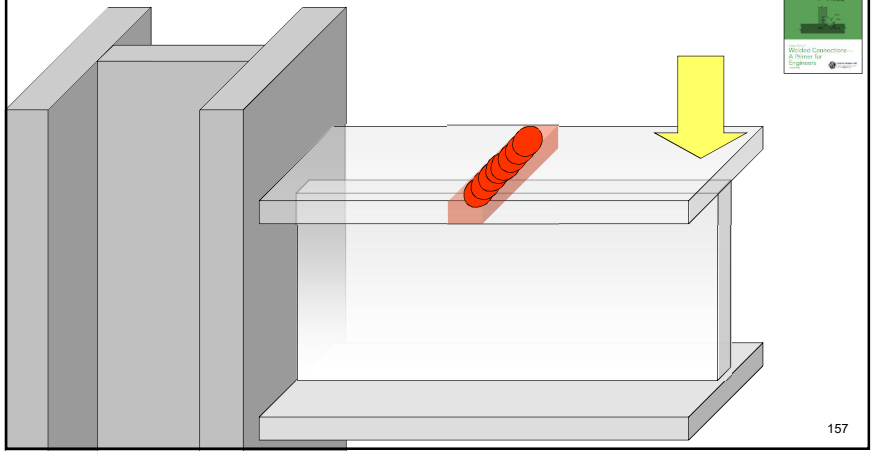






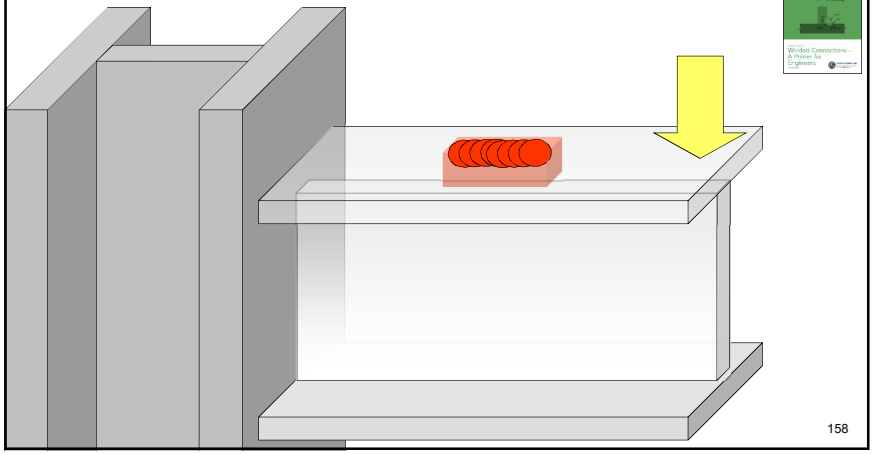


SPECIAL WELDING APPLICATIONS



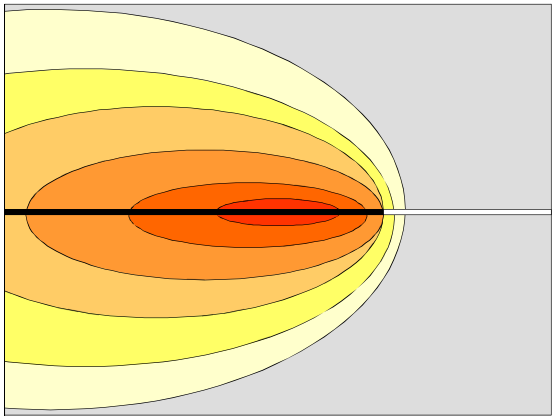
157

SPECIAL WELDING APPLICATIONS



158

SPECIAL WELDING APPLICATIONS



159

AISC 360-16 Specification for Structural Steel Buildings

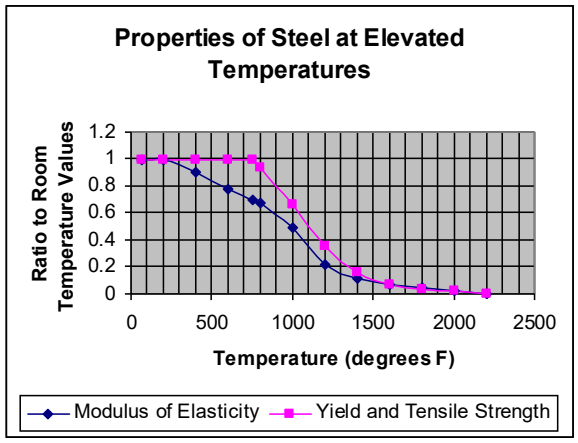
Table A-4.2.1
Properties of Steel at Elevated Temperatures

Steel Tempreature (°F)[°C]	$k_E = E_m / E$	$k_y = F_{ym} / F_y$	$k_u = F_{um} / F_y$
68 [20]	*	*	*
200 [93]	1.00	*	*
400 [204]	0.90	*	*
600 [316]	0.78	*	*
750 [399]	0.70	1.00	1.00
800 [427]	0.67	0.94	0.94
1000 [538]	0.49	0.66	0.66
1200 [649]	0.22	0.35	0.35
1400 [760]	0.11	0.16	0.16
1600 [871]	0.07	0.07	0.07
1800 [982]	0.05	0.04	0.04
2000 [1093]	0.02	0.02	0.02
2200 [1204]	0.00	0.00	0.00

*Use ambient properties.

160

SPECIAL WELDING APPLICATIONS



161

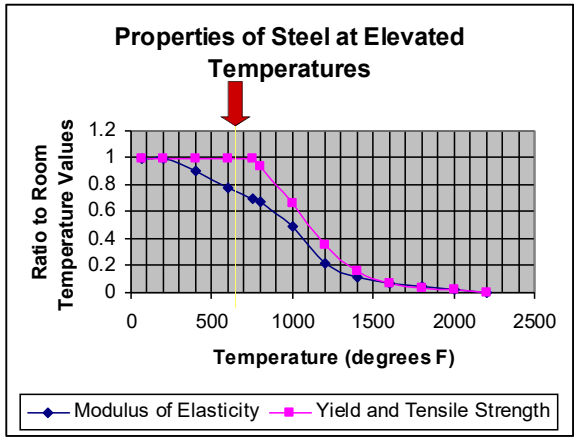
SPECIAL WELDING APPLICATIONS

Welding on members under load

- The amount of material at temperatures >650 °F is negligible (Blodgett)
- Only a very small percentage of the cross section experiences reduced properties (Tide)
- The impact of the weld orientation (longitudinal versus transverse) is typically inconsequential (Ricker)
- Each situation should be checked

162

SPECIAL WELDING APPLICATIONS



163

SPECIAL WELDING APPLICATIONS

14.9 Welding on Existing Structures

- Historic steels
- Welding under load
- Fire
- Cold working / strain aging

164

SPECIAL WELDING APPLICATIONS

Welding on Existing Structures

- General precaution: Fire!
  - From combustibles
  - From unintended work circuits
  - Thermal cutting is typically >> problem than welding

165

SPECIAL WELDING APPLICATIONS

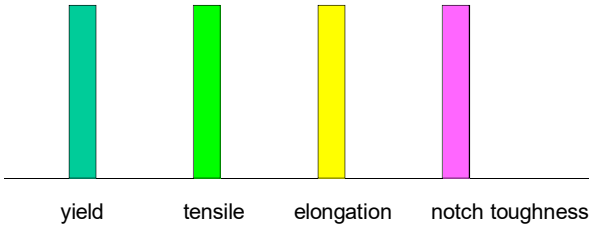
14.9 Welding on Existing Structures

- Historic steels
- Welding under load
- Fire
- Cold working / strain aging

166

SPECIAL WELDING APPLICATIONS

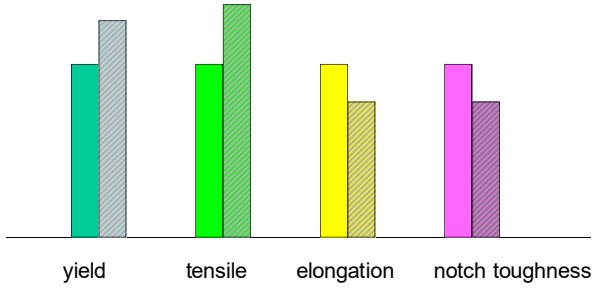
As received hot rolled steel



167

SPECIAL WELDING APPLICATIONS

Effects of cold working



168

SPECIAL WELDING APPLICATIONS

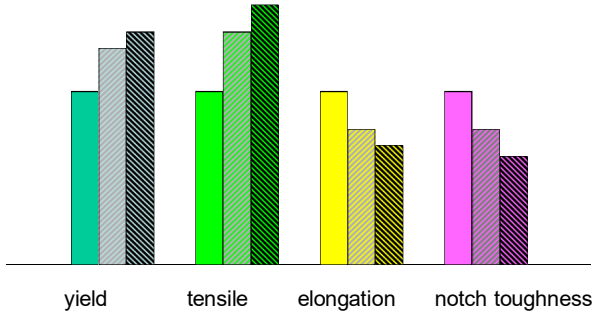
Strain Aging

- Occurs when steel is heated to 400-700 °F
- Yield, tensile increase
- Ductility, notch toughness decrease
- Aggravated by presence of “free” nitrogen
- Stress relief helps, but…
  - Typically impractical
  - Depending on alloy, may experience cracking (Cr, Mo, V, B)

169

SPECIAL WELDING APPLICATIONS

Effects of strain aging



170

SPECIAL WELDING APPLICATIONS

Welding on plastically deformed members

- Reduced notch toughness
  - Make sure material is crack and notch free
- Reduced ductility
  - Minimize practices that increase ductility demand

171

AWS D1.1:2015 STRUCTURAL WELDING CODE

8. Strengthening and Repair of Existing Structures

8.1 General

Strengthening or repairing an existing structure shall consist of modifications to meet design requirements specified by the Engineer. The Engineer shall prepare a comprehensive plan for the work. Such plans shall include, but are not limited to, design, workmanship, inspection, and documentation. Except as modified in this section, all provisions of this code shall apply equally to the strengthening and repairing of existing structures, including heat straightening of distorted members.

8.2 Base Metal

8.2.1 Investigation. Before preparing drawings and specifications for strengthening or repairing existing structures, the types of base metal used in the original

8.3.2 Stress Analysis. An analysis of stresses in the area affected by the strengthening or repair shall be made. Stress levels shall be established for all in-situ dead and live load cases. Consideration shall be made for accumulated damage that members may have sustained in past service.

8.3.3 Fatigue History. Members subject to cyclic loading shall be designed according to the requirements for fatigue stresses. The previous loading history shall be considered in the design. When the loading history is not available, it shall be estimated.

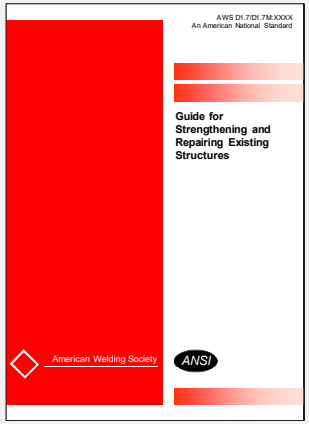
8.3.4 Restoration or Replacement. Determination shall be made whether the repairs should consist of restoring corroded or otherwise damaged parts or of replacing entire members.

8.3.5 Loading During Operations. The Engineer shall

172

AWS D1.7

Guide for Strengthening and Repairing Exiting Structures



173

SPECIAL WELDING APPLICATIONS

Welding on Existing Structures: Summary

- May involve historic steel: see DG 21 Chapter 4
- Welding on members under load: Caution
- Fire potential: sparks, resistance heating: Caution
- Welding on cold worked steel: local reduced ductility

174

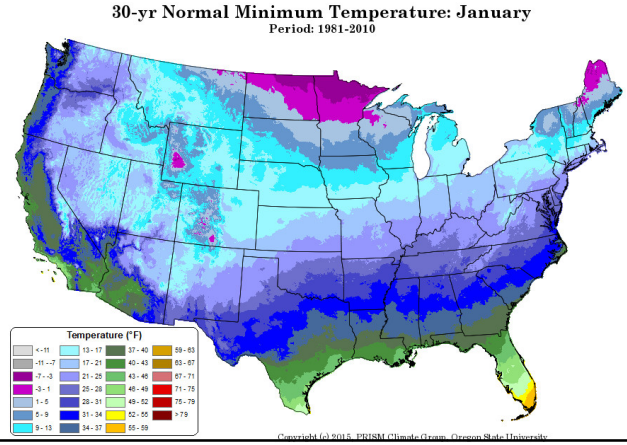
SPECIAL WELDING APPLICATIONS

Today's Webinar

14.4 Welding on Heavy Shapes
14.6 Welding HSS
14.7 Welding AESS
14.8 Shop Versus Field Welding
14.9 Welding on Existing Structures
14.12 Cold Temperature Applications
14.15 Heat Shrinking
14.16 Buttering

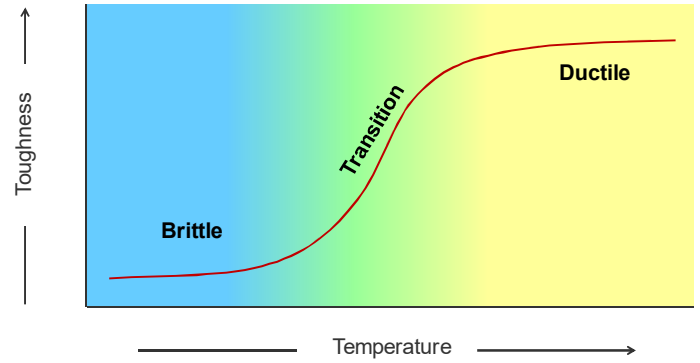
175

SPECIAL WELDING APPLICATIONS



176

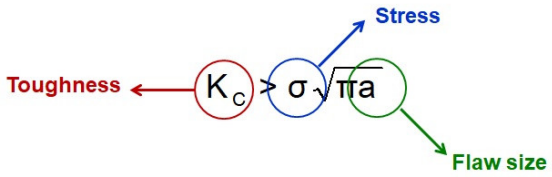
SPECIAL WELDING APPLICATIONS



177

SPECIAL WELDING APPLICATIONS

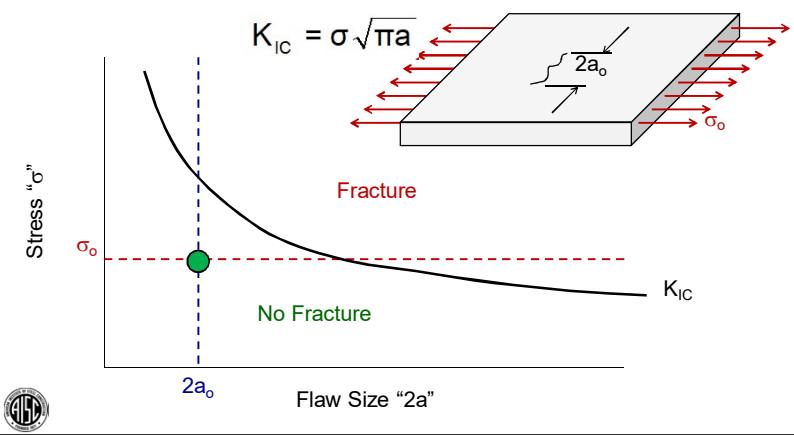
An infinite number of **correct** answers.



An infinite number of **incorrect** answers.

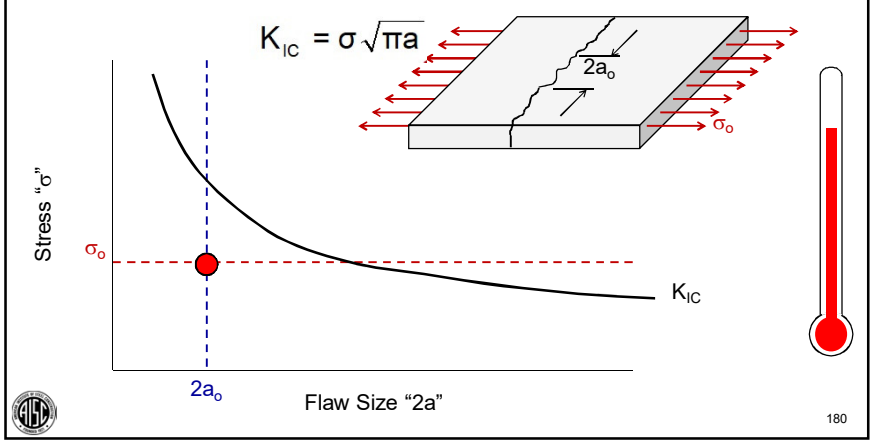
178

SPECIAL WELDING APPLICATIONS

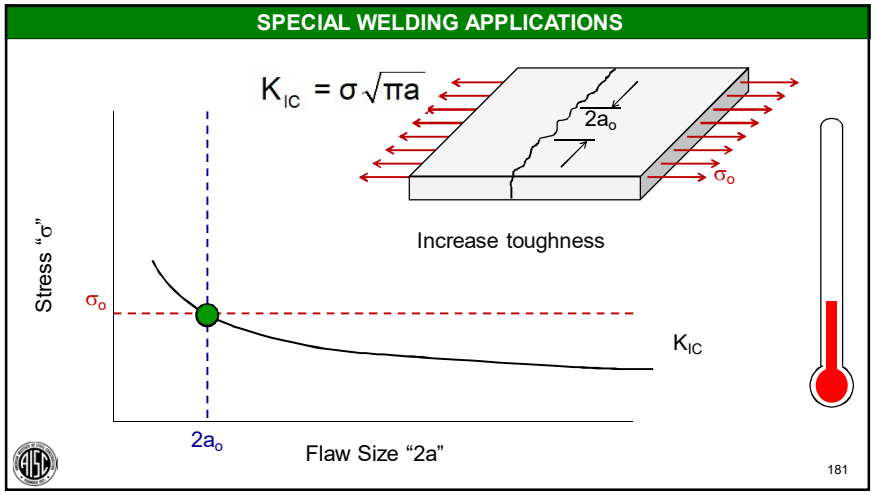


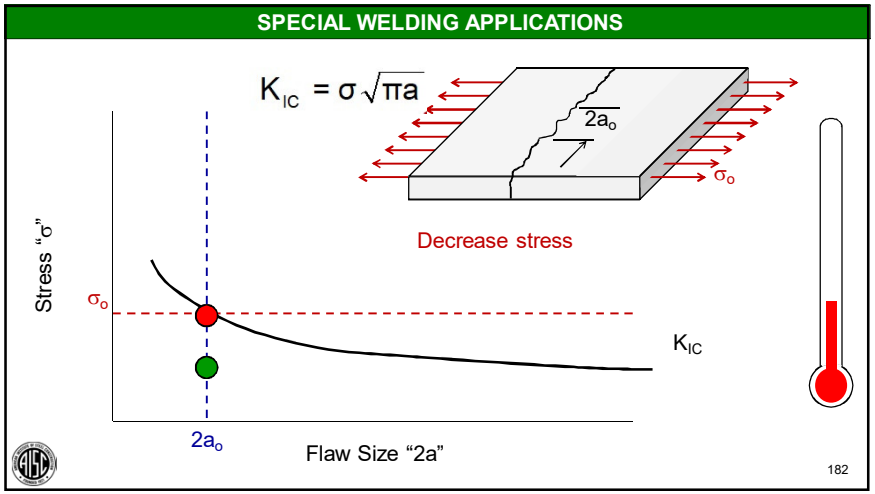
179

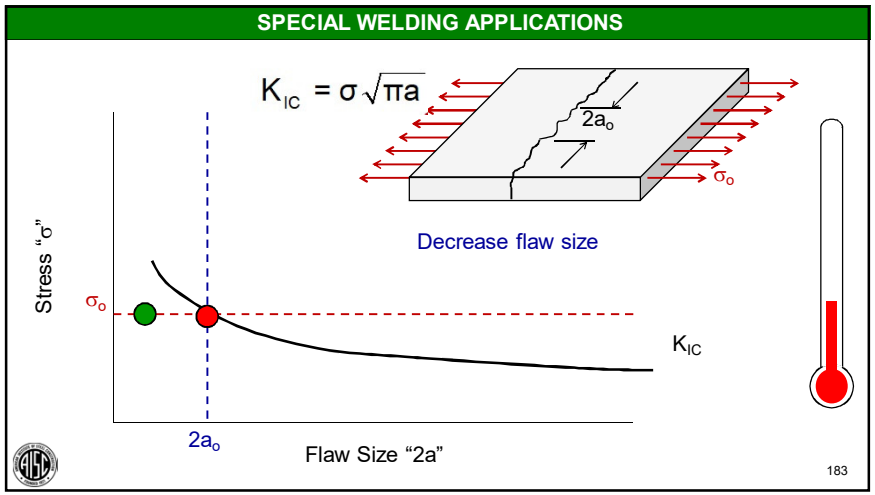
SPECIAL WELDING APPLICATIONS

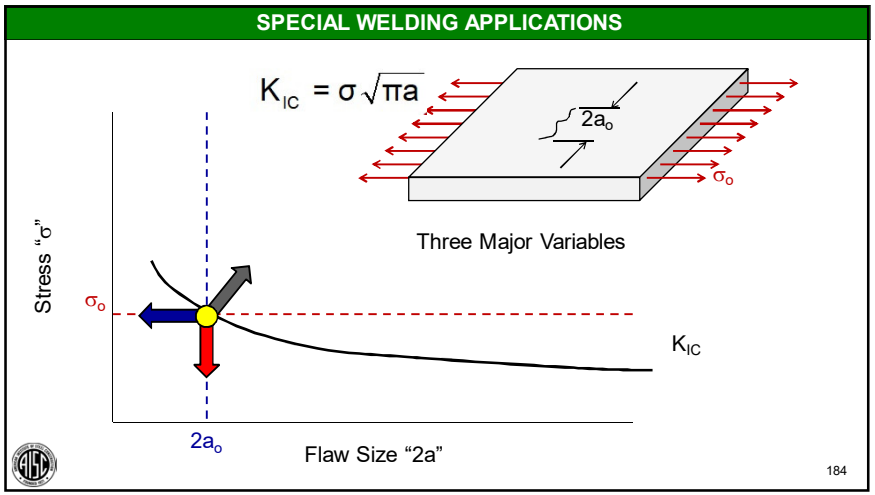


180







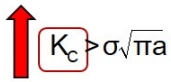


AISC 360-16 Specification for Structural Steel Buildings

Commentary A3. MATERIAL

1a. ASTM Designations

"For especially demanding service conditions such as structures exposed to low temperatures, particularly those with impact loading, the specification of steels with superior notch toughness may be warranted."



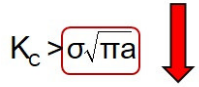
185

AISC 360-16 Specification for Structural Steel Buildings

Commentary A3. MATERIAL

1a. ASTM Designations

"Good workmanship and good design details incorporating joint geometry that avoids severe stress concentrations are generally the most effective means of providing fracture-resistant construction."



186

SPECIAL WELDING APPLICATIONS

Cold Temperature Applications: Summary

Material | Details | Workmanship | Inspection

For "good design details" and joint geometries that "avoid severe stress concentrations", consider Appendix 3 Design for Fatigue.

187

SPECIAL WELDING APPLICATIONS

Today's Webinar

14.4 Welding on Heavy Shapes
14.6 Welding HSS
14.7 Welding AESS
14.8 Shop Versus Field Welding
14.9 Welding on Existing Structures
14.12 Cold Temperature Applications
14.15 Heat Shrinking
14.16 Buttering

188

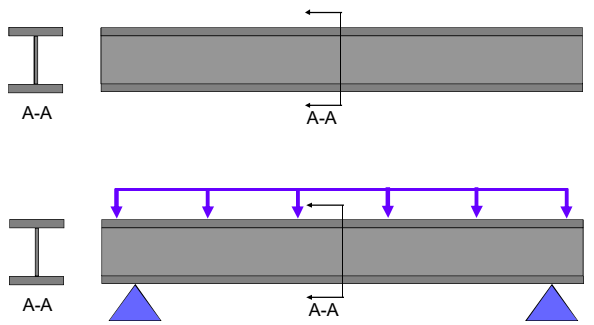
SPECIAL WELDING APPLICATIONS

Heat Shrinking

- Used to curve straight steel
- Used to straighten bent steel
- Used to correct for distortion
- Also known as “heat straightening”

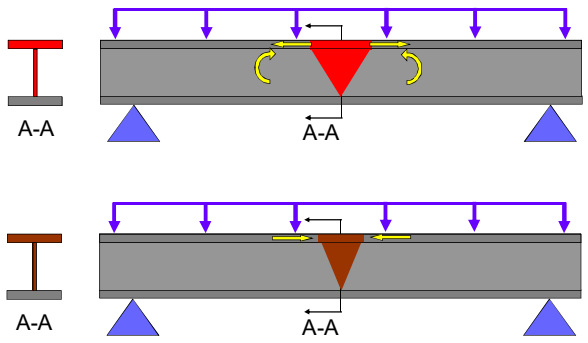
189

SPECIAL WELDING APPLICATIONS



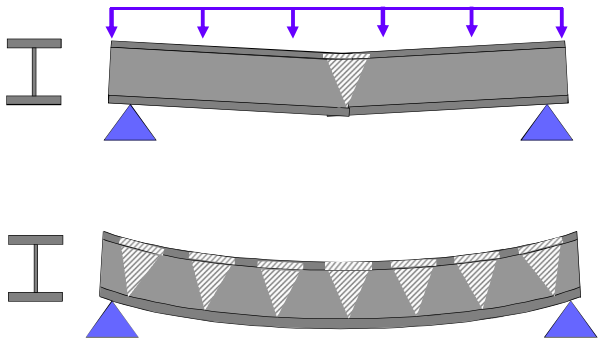
190

SPECIAL WELDING APPLICATIONS

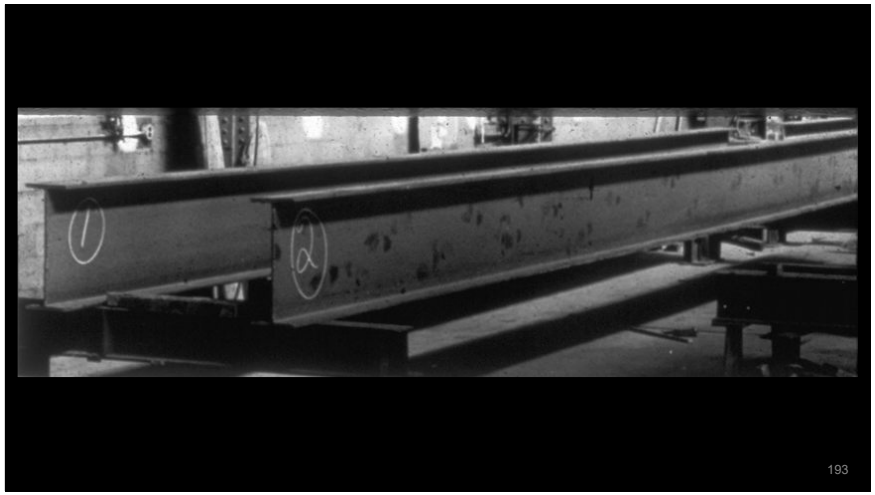


191

SPECIAL WELDING APPLICATIONS



192



SPECIAL WELDING APPLICATIONS

Heat Shrinking

- 1200 °F temperature limit for hot rolled steels
- 1100 °F temperature limit for quenched and tempered steels
- Pre-stress of up to 50% of room temperature yield (Avent)

196

AWS D1.1:2015 STRUCTURAL WELDING CODE

5.25.2 Localized Heat Repair Temperature Limitations.

Members distorted by welding shall be straightened by mechanical means or by application of a limited amount of localized heat. The temperature of heated areas as measured by approved methods shall not exceed 1100°F [600°C] for quenched and tempered steel nor 1200°F [650°C] for other steels. The part to be heated for straightening shall be substantially free of stress and from external forces, except those stresses resulting from the mechanical straightening method used in conjunction with the application of heat.

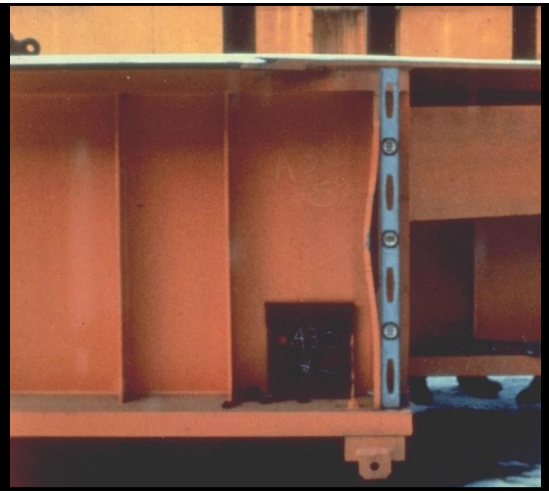
197

SPECIAL WELDING APPLICATIONS

Heat Shrinking

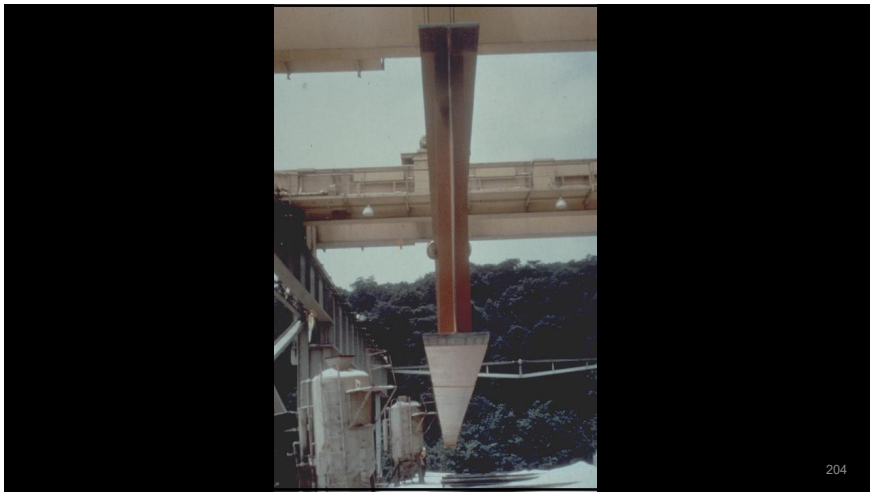
- For new steel being curved
  - No change in modulus of elasticity (E)
  - Slight increase in yield and tensile strength
  - 10-25% increase in ductility
- For bent steel being straightened
  - Yield strength increases 10%
  - Tensile strength increases 4-6%

198

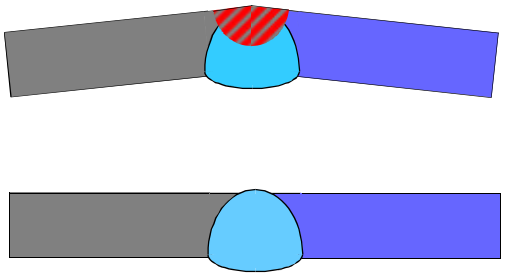


199

200

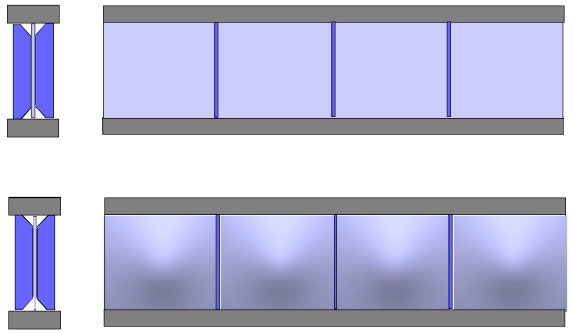


Correcting Angular Distortion



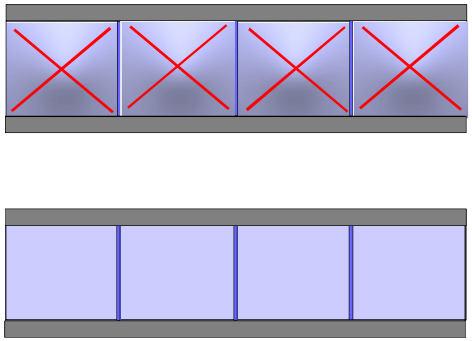
205

Correcting Panel Distortion



206

Correcting Panel Distortion



207

SPECIAL WELDING APPLICATIONS

Heat Shrinking: Summary

- Used for shaping and straightening steel
- Code limits on temperatures
- Material is not damaged if properly done

208

SPECIAL WELDING APPLICATIONS

Today's Webinar

14.4 Welding on Heavy Shapes
14.6 Welding HSS
14.7 Welding AESS
14.8 Shop Versus Field Welding
14.9 Welding on Existing Structures
14.12 Cold Temperature Applications
14.15 Heat Shrinking
14.16 Buttering

209

SPECIAL WELDING APPLICATIONS

BUTTERING

210

AWS STANDARD WELDING TERMS & DEFINITIONS (A3.0:2010)

buttering.
A surface variation depositing surfacing metal on one or more surfaces to provide metallurgically compatible weld metal for the subsequent completing of the weld.

211

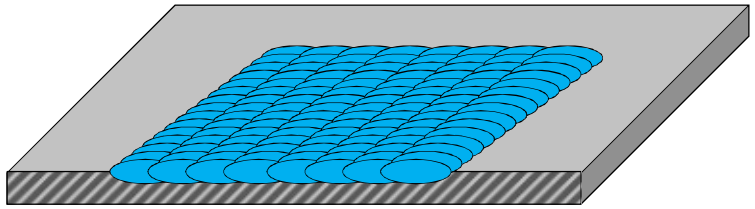
SPECIAL WELDING APPLICATIONS

Buttering is used to:

- Mitigate lamellar tearing tendencies
- Build up the faces of groove weld joint cavities where root openings are excessive
- Restore material from steel that was damaged by corrosion
- Enable welding on "hard to weld" steels

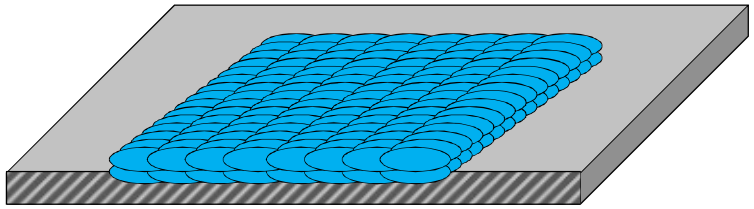
212

SPECIAL WELDING APPLICATIONS



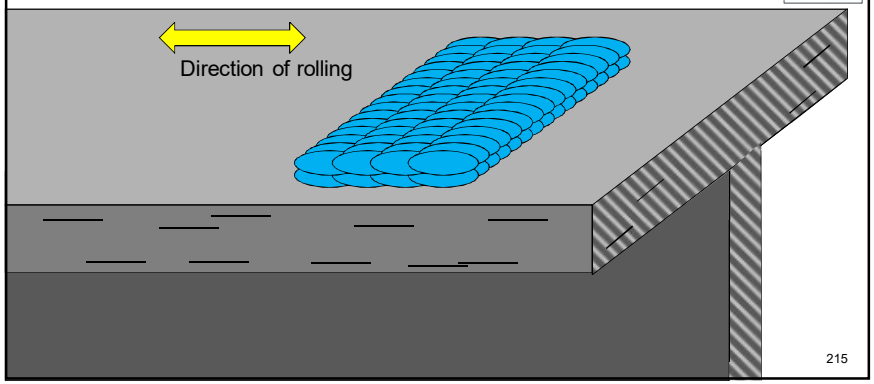
213

SPECIAL WELDING APPLICATIONS



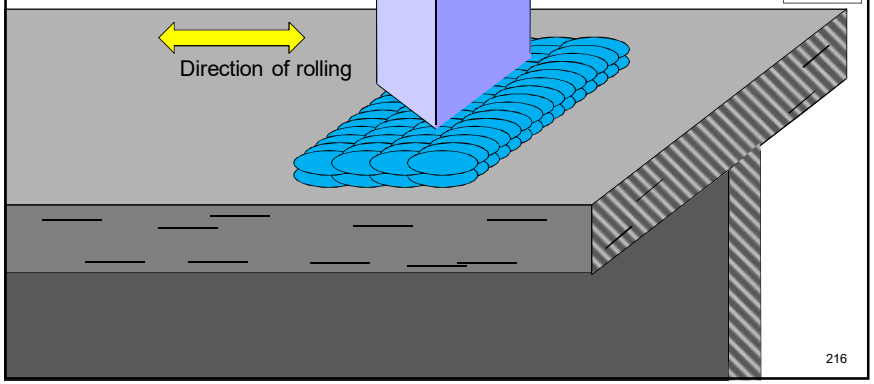
214

SPECIAL WELDING APPLICATIONS



215

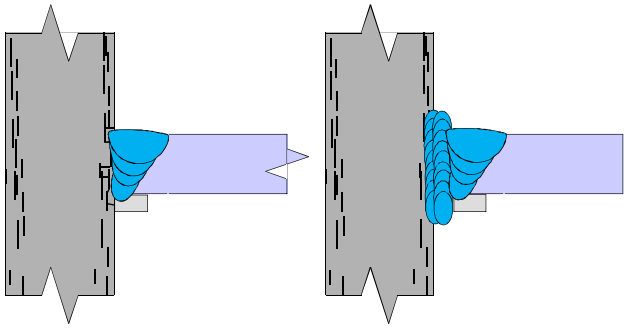
SPECIAL WELDING APPLICATIONS



216

SPECIAL WELDING APPLICATIONS

Buttering Solution



Sensitive Detail Buttered Detail

217

SPECIAL WELDING APPLICATIONS

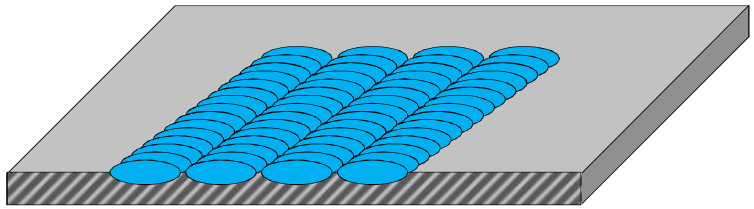
Buttering Guidelines

- Deposit butter layers with the same care and controls used for joining welds (WPSs, qualified welders, in process visual inspection, etc.)
- Overlap bead by approximately 50%

218

SPECIAL WELDING APPLICATIONS

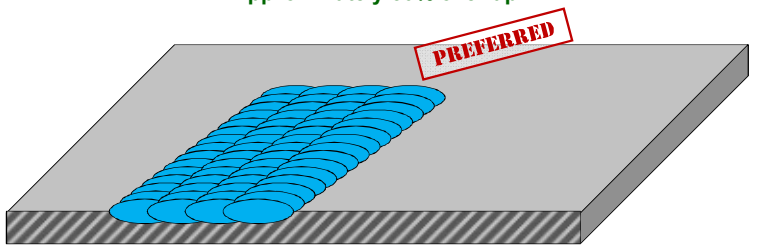
Non-preferred: no overlap



219

SPECIAL WELDING APPLICATIONS

Approximately 50% overlap



220

SPECIAL WELDING APPLICATIONS

Buttering Guidelines

- Deposit butter layers with the same care and controls used for joining welds (WPSs. Qualified welders, in process visual inspection, etc.)
- Overlap bead by approximately 50%.
- If NDT of the weld to be made to the butter layer is required, the butter layer should also receive NDT.

221

SPECIAL WELDING APPLICATIONS

Buttering: Summary

- Build up out-of-tolerance joints
- One method to mitigate lamellar tearing
- Buttering procedures should be consistent with the applicable code, including final quality requirements

222

SPECIAL WELDING APPLICATIONS

Today's Webinar

14.4 Welding on Heavy Shapes
14.6 Welding HSS
14.7 Welding AESS
14.8 Shop Versus Field Welding
14.9 Welding on Existing Structures
14.12 Cold Temperature Applications
14.15 Heat Shrinking
14.16 Buttering

223

SPECIAL WELDING APPLICATIONS

224

Thank you!

AISC | Questions?

Smarter. Stronger. Steel.

Individual Session Registrants

PDH Certificates

- You will receive an email on how to report attendance from: registration@aisc.org.
- Be on the lookout: Check your spam filter! Check your junk folder!
- Completely fill out online form. Don't forget to check the boxes next to each attendee's name!

Smarter. Stronger. Steel.

Individual Session Registrants

PDH Certificates

- Reporting site (URL will be provided in the forthcoming email).
- Username: Same as AISC website username.
- Password: Same as AISC website password.

Smarter. Stronger. Steel.

8-Session Registrants

PDH Certificates

One certificate will be issued at the conclusion of all 8 sessions.

Smarter. Stronger. Steel.

8-Session Registrants

Access to the quiz

Information for accessing the quiz will be emailed to you by Thursday. It will contain a link to access the quiz. EMAIL COMES FROM NIGHTSCHOOL@AISC.ORG.

Quiz and attendance records

Posted Thursday mornings. www.aisc.org/nightschool -- Click on Current Course Details.

Reasons for quiz

- EEU – You must take all quizzes and the final exam to receive EEU.
- PDHs – If you watch a recorded session, you must pass quiz for PDHs.
- REINFORCEMENT – Reinforce what you learn tonight. Get more out of the course.

Note: If you attend the live presentation, you do not have to take the quizzes to receive PDHs

Smarter. Stronger. Steel.

8-Session Registrants

Access to the recording

Information for accessing the recording will be emailed to you by Thursday. The recording will be available for four weeks. (For 8-session registrants only.) EMAIL COMES FROM NIGHTSCHOOL@AISC.ORG.

PDHs via recording

If you watch a recorded session, you must take *and pass* the quiz for PDHs.

Smarter. Stronger. Steel.

8-Session Registrants

Night School Resources

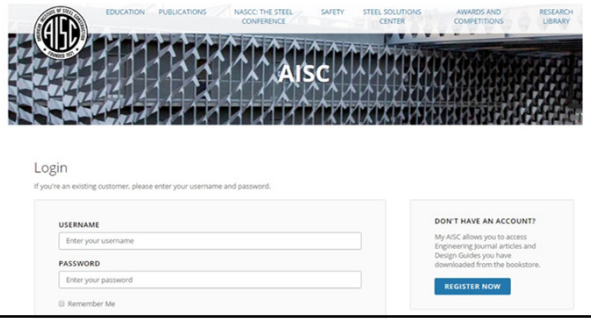
Find all your handouts, quizzes and quiz scores, recording access, and attendance information all in one place!

Smarter. Stronger. Steel.

8-Session Registrants

Night School Resources

Go to www.aisc.org and sign in.

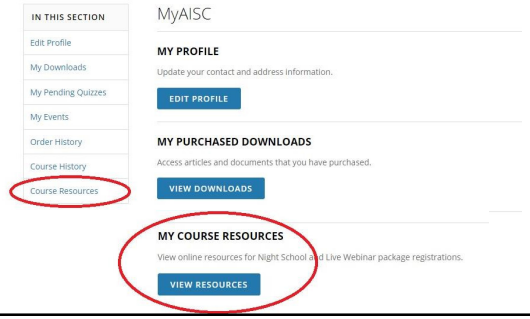


Smarter. Stronger. Steel.

8-Session Registrants

Night School Resources

Go to www.aisc.org and sign in.



Smarter. Stronger. Steel.

8-Session Registrants

Night School Resources

Course Resources

Event	Start Date
NS 13 8-Session Package-Night School 13 - Design of Industrial Buildings	1/30/2017 7:00:00 PM
NS 14 8-Session Package-Night School 14 - Fundamentals of Stability	6/5/2017 7:00:00 PM

Smarter. Stronger. Steel.

8-Session Registrants

Night School Resources

Night School 13: Design of Industrial Buildings

8-SESSION PACKAGE RESOURCES

Event	Date	Handouts	Video	Quiz	Attendance
NS13 - Design Criteria	1/30/2017 7:00:00 PM	Handouts	View Passcode: NS13DSN	Pass Score: 80	Pending
NS13 - Economic Considerations	2/6/2017 7:00:00 PM	Handouts	Available 02/08/2017 5pm EST	Available 02/08/2017 5pm EST	Pending
NS13 - Lateral Load Systems and Details	2/13/2017 7:00:00 PM	Handouts	Available 02/15/2017 5pm EST	Available 02/15/2017 5pm EST	Pending
NS13 - Preliminary Design Procedures	2/27/2017 7:00:00 PM	Handouts	Available 03/01/2017 5pm EST	Available 03/01/2017 5pm EST	Pending
NS13 - Crane Girder Design and Frame Analysis	3/6/2017 7:00:00 PM	Handouts	Available 03/08/2017 5pm EST	Available 03/08/2017 5pm EST	Pending
NS13 - Frame Member and Connection Design	3/13/2017 7:00:00 PM	Handouts	Available 03/15/2017 5pm EST	Available 03/15/2017 5pm EST	Pending
NS13 - Transfer Crane Girder & Longitudinal Bldg Bracing Dsn	3/27/2017 7:00:00 PM	Handouts	Available 03/29/2017 5pm EST	Available 03/29/2017 5pm EST	Pending

Smarter. Stronger. Steel.

8-Session Registrants

Night School Resources

- Weekly "quiz and recording" email.
- Weekly updates of the master quiz and attendance record, found at www.aisc.org/nightschool21. Scroll down to Quiz and Attendance records.
  - Updated on Thursday mornings.

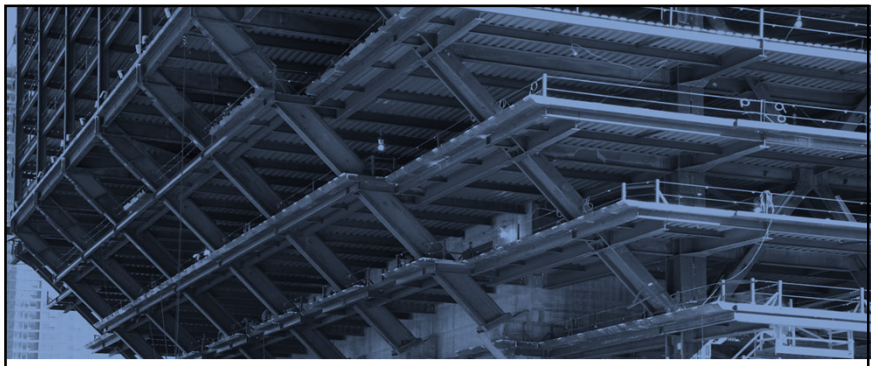
Smarter. Stronger. Steel.

8-Session Registrants

Night School Resources

- Webinar connection information
  - Reminder email sent out Tuesday mornings
- Links to handouts also found here

Smarter. Stronger. Steel.



AISC | Thank you

Smarter. Stronger. Steel.