

**Night School 27:  
Fundamentals of  
Welding and Bolting**

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Please standby.

**AISC  
Night School**



**Session 4 – Problems and Fixes**

October 25, 2021 | Duane K. Miller



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Stronger.  
Steel.**



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## Course Description

### Problems and Fixes October 25, 2021

This session covers problems associated with structural steel construction and provides solutions to many issues. Topics such as repairs to base metal, out-of-tolerance weld joints, repairs to welds, welding on anchor rods including extending rods that are too short, repairing lamellar tears and more are addressed in this session. In all cases, the session provides practical solutions to these common problems.





## Learning Objectives

- Describe all considerations for making repairs to base metal.
- List weldability concerns with extending anchor rods.
- Describe tolerance issues that may affect welded joints.
- Describe how to address a weld performed without proper inspection.



## Night School 27: Fundamentals of Welding and Bolting



Curtis L. Decker, PhD, PE,  
SE, The Lincoln Electric  
Company



Duane K. Miller, PE, ScD,  
The Lincoln Electric  
Company



Chad Larson, LeJeune  
Bolt Company



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Steel.

# Night School 27: Fundamentals of Welding and Bolting

Welding Part 4: Problems and Fixes  
October 25, 2021

Duane K. Miller, PE, ScD, The Lincoln Electric Company



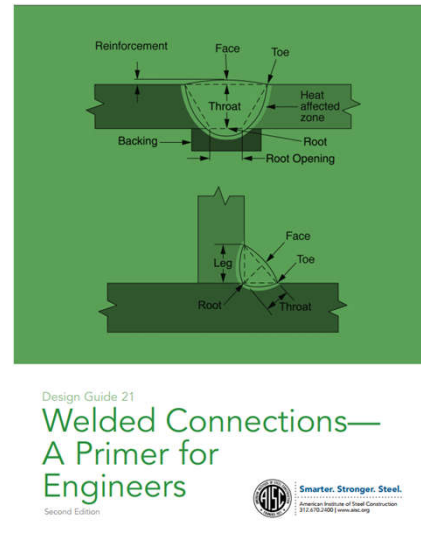
## PROBLEMS AND FIXES



## AISC Design Guide 21, 2<sup>nd</sup> Edition

Welded Connections – A Primer for  
Engineers

### Chapter 15: Problems and Fixes



## AWS D1.1

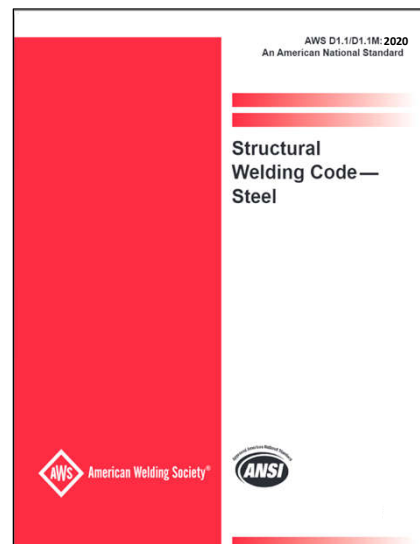
Structural Welding Code – Steel

“...with the approval of the Engineer...”

“...when approved by the Engineer...”

“...Engineer approval shall be required...”

“...discretion of the Engineer...”

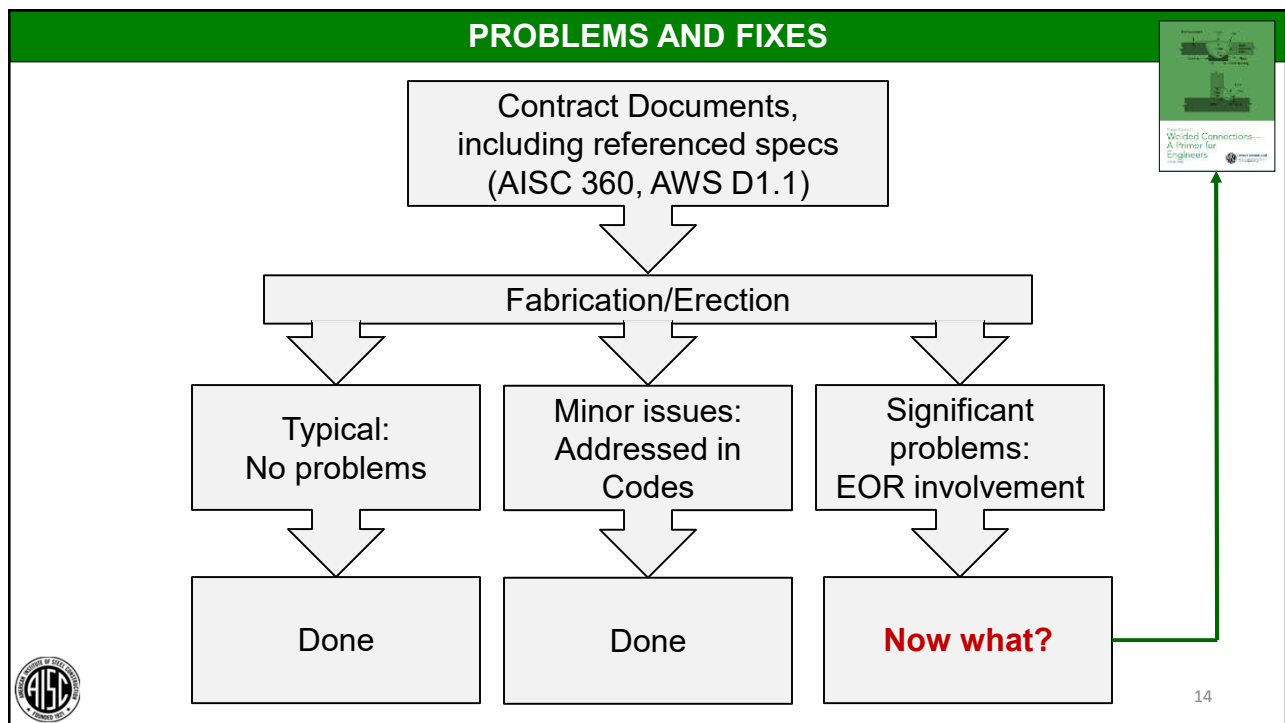



### AWS D1.1:2020 Structural Welding Code--Steel

**7.25.3 Engineer's Approval.**

**Prior approval of the Engineer** shall be obtained for repairs to base metal (other than those required by 7.14), repair of major or delayed cracks, repairs to ESW and EGW with internal defects, or for a revised design to compensate for deficiencies. The Engineer shall be notified before welded members are cut apart.

13



## PROBLEMS AND FIXES



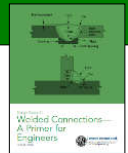
### Chapter 15: Problems and Fixes

- 15.1 Repairs to Base Metal
- 15.2 Repairs to Cut Edges
- 15.3 Butt Joint Alignment
- 15.4 Out-of-Tolerance Weld Joints
- 15.5 Fixing Members that are Cut Short
- 15.6 Repair of Mislocated Holes
- 15.7 Use of Plug Welds in Lieu of Bolts
- 15.8 Repairs to Welds



15

## PROBLEMS AND FIXES



### Chapter 15: Problems and Fixes

- 15.9 Heat Shrinking of Q&T Steel
- 15.10 Unspecified Welds
- 15.11 Welds Made Without Inspection
- 15.12 Welding on Anchor Rods
- 15.13 Welding Anchor Rod-to-Base Plates
- 15.14 Removing and Reinstalling Column Base Plates
- 15.15 Repairing Lamellar Tears



16

## PROBLEMS AND FIXES



### Chapter 15: Problems and Fixes

- ➔ 15.1 Repairs to Base Metal
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17

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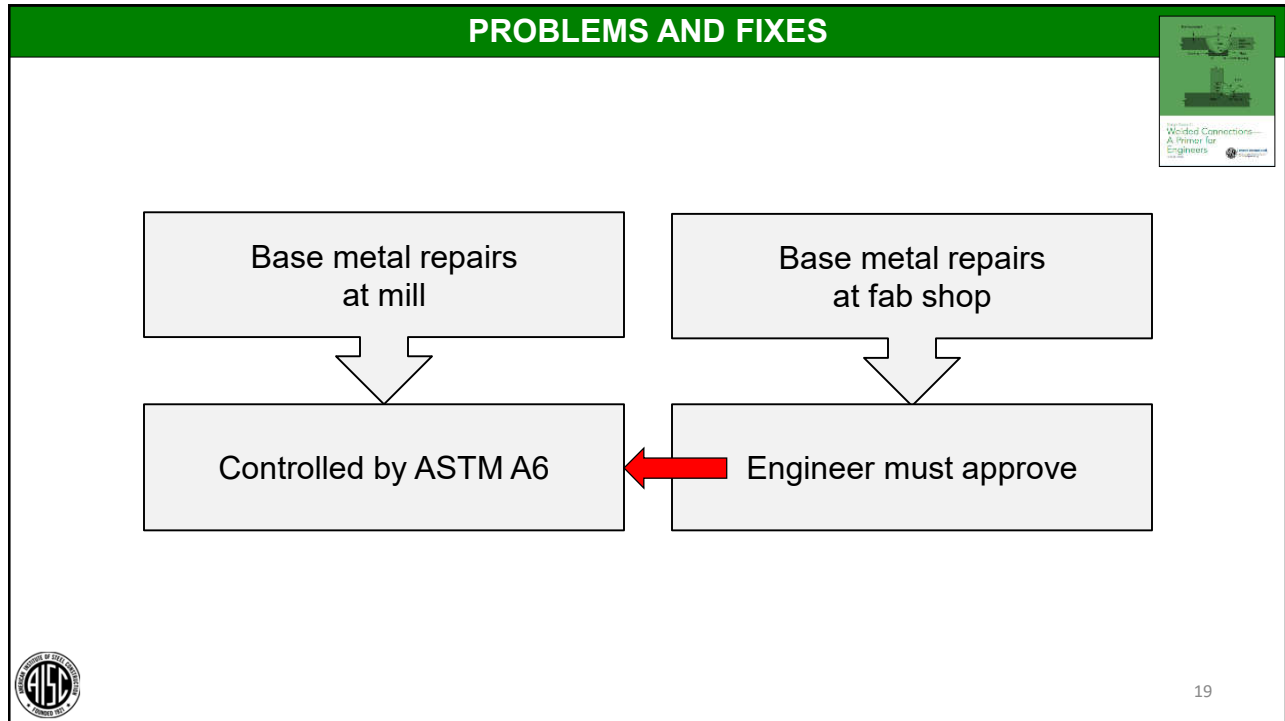


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18



**PROBLEMS AND FIXES**

**15.1.2 Repair of Mill-Induced Discontinuities**

**Table 15-1. Limits on Imperfection Repaired by Grinding**

Material Thickness, in. (mm)	Maximum Removal Depth, in. (mm)
< 3/8 (10)	1/32 (1)
3/8 (10) – 2 (50)	1/16 (2)
> 2 (50)	1/8 (3)

*This table was adapted from ASTM A6, Section 9.2.*

20

## PROBLEMS AND FIXES



### 15.1.2 Repair of Mill-Induced Discontinuities

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> 2 (50)	1/8 (3)

*This table was adapted from ASTM A6, Section 9.2.*



21

## ASTM A6 (summary)

- The total area of ground material must not exceed 2% of the total surface area of that piece.
- The reduction in thickness by grinding must not exceed 30% of the nominal thickness of the material at the location of the imperfection, nor exceed 1-1/4 in. (31 mm).
- For defects that require deeper removal depths than those shown in Table 15-1, repair by welding is permitted.



22

### PROBLEMS AND FIXES

23

AWS D1.8/D1.8M:2016  
**Structural Welding Code—  
Seismic Welding Supplement**

24

## AWS D1.8:2016 Seismic Welding Supplement



### 6.18.5 Repair of Gouges and Notches.

Gouges and notches in the **Protected Zone** shall be repaired as follows:

#### 6.18.5.1 Grinding.

When gouges and notches are repaired by grinding, the ground area shall provide a gradual taper to the surface of the base metal. **In the direction parallel to the member axis, the taper shall not be greater than 1:5.** **In the direction transverse to the member axis, the taper shall not be greater than 1:2.5.**



25

## PROBLEMS AND FIXES



### Repairs to Base Metal: Summary

- EOR involvement needed for repairs made in the base metal in the shop, but not in the mill
- DG21 recommendation: apply ASTM A6 criteria to shop repairs
- DG21 recommendation: for slope: D1.8 provides a conservative criteria
- For welded repairs, location of repair should be considered



26

**PROBLEMS AND FIXES**




**Chapter 15: Problems and Fixes**

- 15.1 Repairs to Base Metal
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 27

**PROBLEMS AND FIXES**



**15.2 Repairs to Cut Edges**

- ➔ • Repairs to mill-induced discontinuities
- Repairs to contractor-induced discontinuities

 28

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### 7.25.3 Engineer's Approval.

Prior approval of the Engineer shall be obtained for repairs to base metal (other than those required by 7.14), repair of major or delayed cracks, repairs to ESW and EGW with internal defects, or for a revised design to compensate for deficiencies. The Engineer shall be notified before welded members are cut apart.



29

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### 7.14.5 Mill-Induced Discontinuities.

The limits of acceptability and the repair of visually observed cut surface discontinuities shall be in conformance with Table 7.4, in which the length of discontinuity is the visible long dimension on the cut surface of material and the depth is the distance that the discontinuity extends into the material from the cut surface. All welded repairs shall be in conformance with this code. Removal of the discontinuity may be done from either surface of the base metal. The aggregate length of welding shall not exceed 20% of the length of the plate surface being repaired except with approval



30

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(4) If the area of the discontinuity W, X, Y, or Z exceeds the allowable in 5.14.5.1(2), the cut material or subcomponent shall be rejected and replaced, or repaired **at the discretion of the Engineer.**



31

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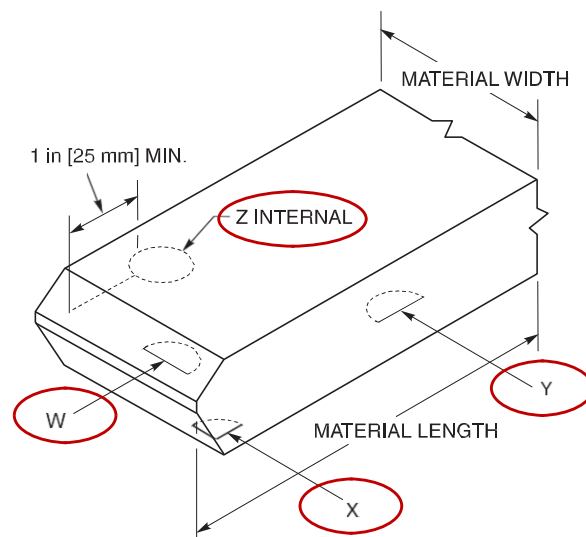
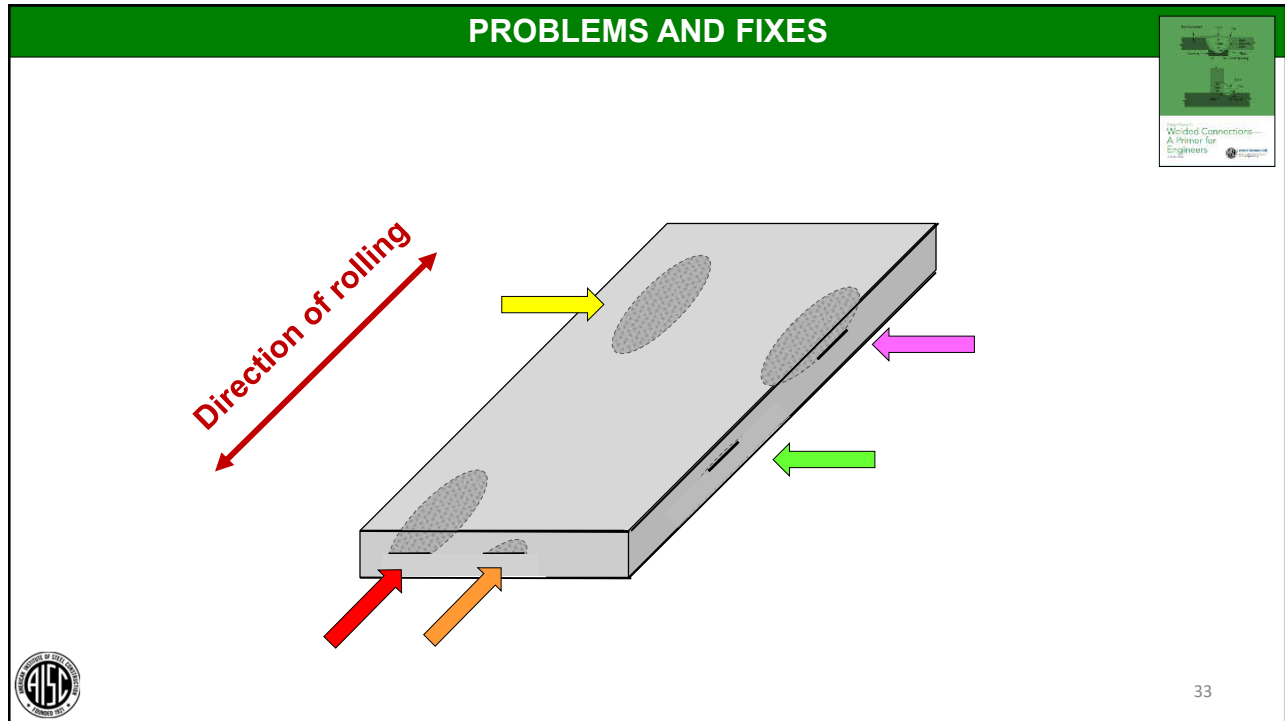


Figure 7.1—Edge Discontinuities in Cut Material



32



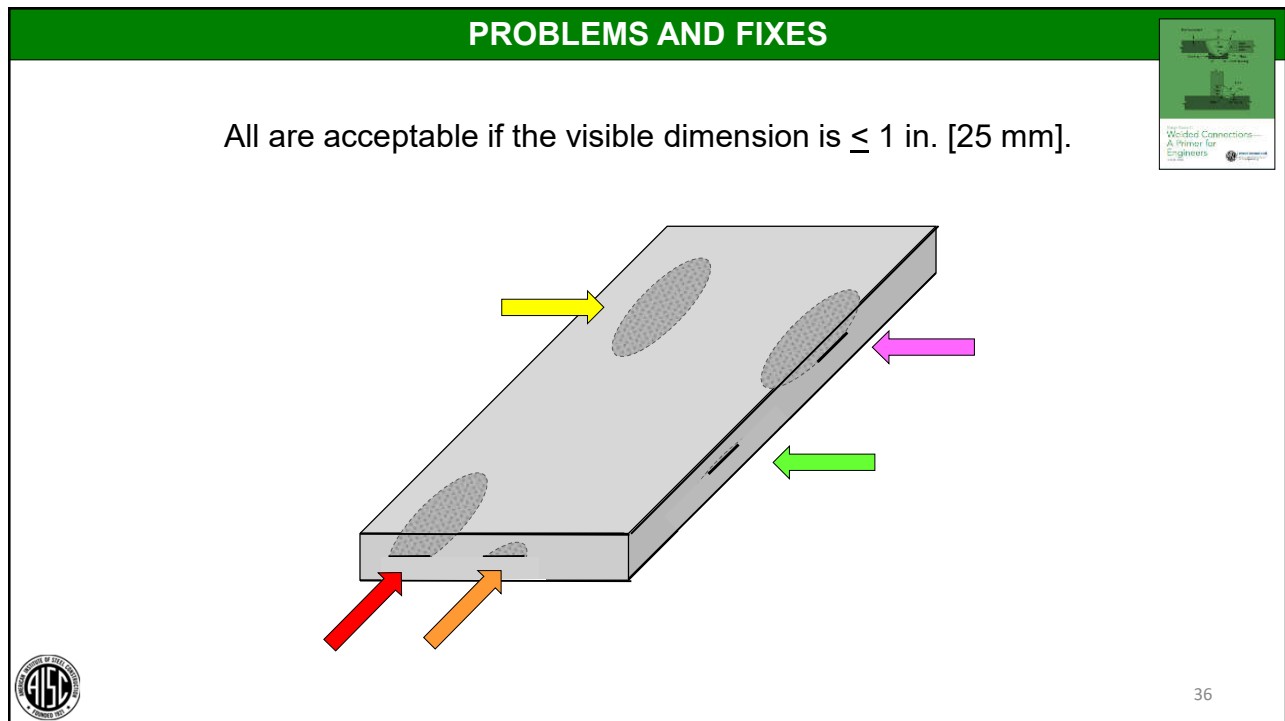
PROBLEMS AND FIXES		
Limits on Acceptability and Repair of Mill Induced Lamellar Discontinuities in Cut Surfaces		
Discontinuity		Repair
Length (L)	Depth	
$\leq 1$ in [25 mm]	any	None, need not be explored
$> 1$ in [25 mm]	$\leq 1/8$ in [3 mm]	None, but determine depth
	$> 1/8$ in [3mm] $\leq 1/4$ in [6 mm]	Remove, need not weld
	$> 1/4$ in [6 mm] $\leq 1$ in [25 mm]	Remove and weld
	$> 1$ in [25 mm]	See 7.14.5.1

Adapted from AWS D1.1, Table 7.4.




PROBLEMS AND FIXES		
Limits on Acceptability and Repair of Mill Induced Laminar Discontinuities in Cut Surfaces		
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**PROBLEMS AND FIXES**




Limits on Acceptability and Repair of Mill Induced Laminar Discontinuities in Cut Surfaces		
Discontinuity		Repair
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Adapted from AWS D1.1, Table 7.4.



37

**PROBLEMS AND FIXES**



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	$> 1$ in [25 mm]	See 7.14.5.1
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Adapted from AWS D1.1, Table 7.4.


38

PROBLEMS AND FIXES		
Limits on Acceptability and Repair of Mill Induced Laminar Discontinuities in Cut Surfaces		
Discontinuity		Repair
Length (L)	Depth	
$\leq 1$ in [25 mm]	any	None, need not be explored
$> 1$ in [25 mm]	$\leq 1/8$ in [3 mm]	None, but <b>determine depth</b>
	$> 1/8$ in [3mm] $\leq 1/4$ in [6 mm]	Remove, need not weld
	$> 1/4$ in [6 mm] $\leq 1$ in [25 mm]	Remove and weld
	$> 1$ in [25 mm]	See 7.14.5.1

Adapted from AWS D1.1, Table 7.4.



**AWS D1.1:2020 Structural Welding Code--Steel**



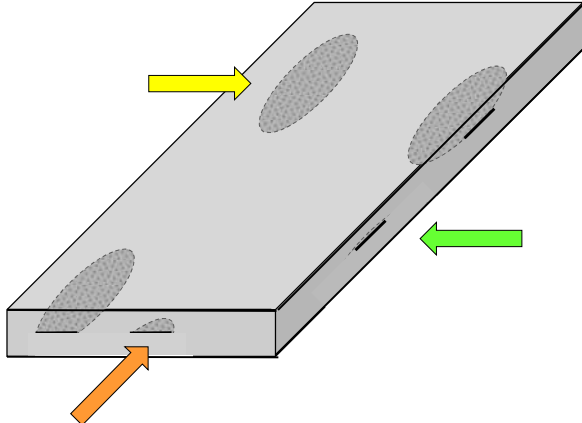
**Note to AWS D1.1 Table 7.4:**

A spot check of 10% of the discontinuities on the cut surface in question should be explored by grinding to determine depth. If the depth of any one of the discontinuities explored exceeds 1/8 in [3 mm], then all of the discontinuities over 1 in [25 mm] in length remaining on that cut surface shall be explored by grinding to determine depth. If none of the discontinuities explored in the 10% spot check have a depth exceeding 1/8 in [3 mm], then the remainder of the discontinuities on that cut surface need not be explored.



### PROBLEMS AND FIXES



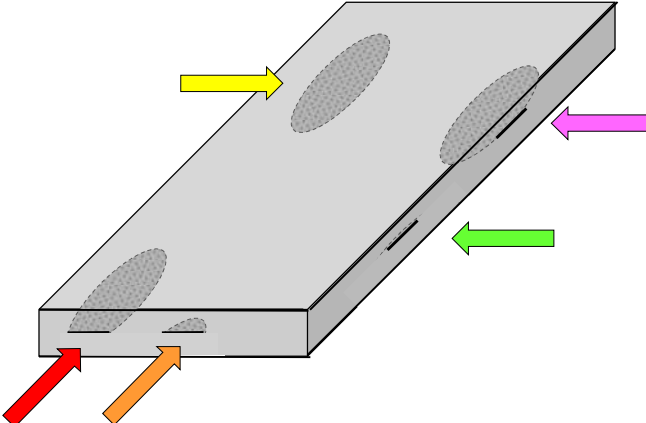
These are acceptable if the visible dimension is > 1 in. [25 mm],  
and depth is less than 1/8 in. [3 mm].



41

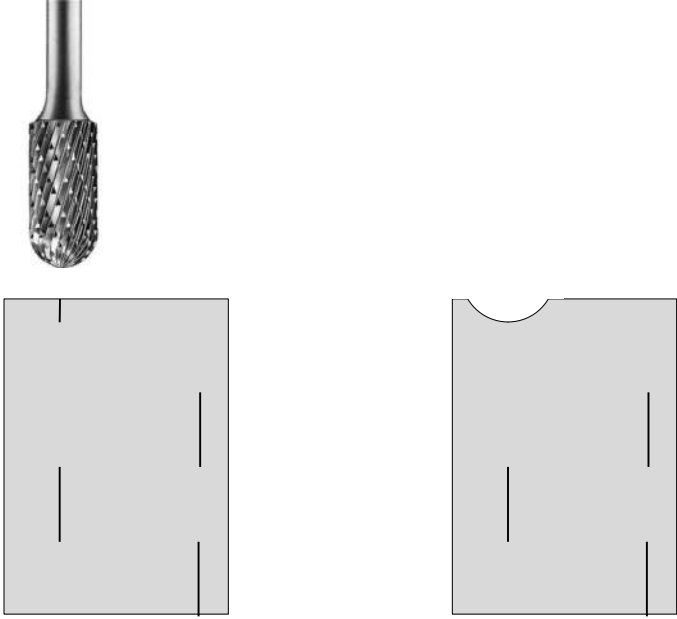
### PROBLEMS AND FIXES


These are acceptable if the visible dimension is > 1 in. [25 mm],  
and depth is less than 1/8 in. [3 mm] if not found in the 10% check.




42

### PROBLEMS AND FIXES

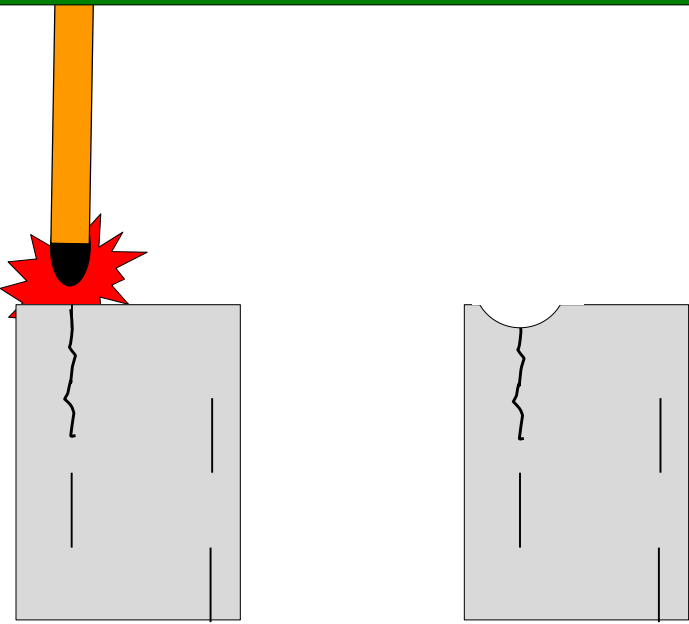



  
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43

### PROBLEMS AND FIXES



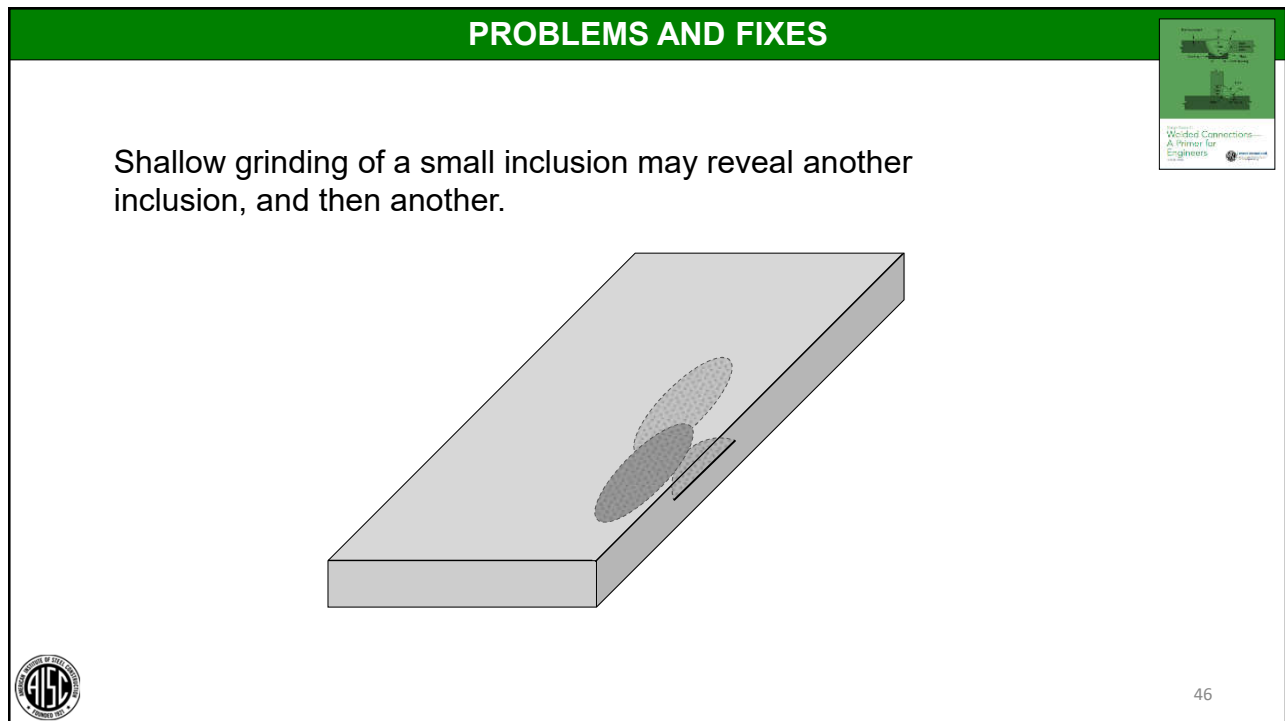
  
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44

PROBLEMS AND FIXES		
Limits on Acceptability and Repair of Mill Induced Laminar Discontinuities in Cut Surfaces		
Discontinuity		Repair
Length (L)	Depth	
$\leq 1$ in [25 mm]	any	None, need not be explored
$> 1$ in [25 mm]	$\leq 1/8$ in [3 mm]	None, but determine depth
	$> 1/8$ in [3mm] $\leq 1/4$ in [6 mm]	Remove, need not weld
	$> 1/4$ in [6 mm] $\leq 1$ in [25 mm]	Remove and weld
	$> 1$ in [25 mm]	See 7.14.5.1

Adapted from AWS D1.1, Table 7.4.




**PROBLEMS AND FIXES**




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Adapted from AWS D1.1, Table 7.4.



47

**PROBLEMS AND FIXES**



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	$> 1/8$ in [3mm] $\leq 1/4$ in [6 mm]	Remove, need not weld
	$> 1/4$ in [6 mm] $\leq 1$ in [25 mm]	Remove and weld
	$> 1$ in [25 mm]	See 7.14.5.1
	$> 1$ in [25 mm]	See 7.14.5.1

Adapted from AWS D1.1, Table 7.4.


48

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### 7.14.5.1 Acceptance Criteria.

For discontinuities greater than 1 in [25 mm] in length and depth discovered on cut surfaces, the following procedures shall be observed.

(1) Where discontinuities such as W, X, or Y in Figure 7.1 are observed prior to completing the joint, the size and shape of the discontinuity shall be determined by UT. ...



49

## AWS D1.1:2020 Structural Welding Code--Steel



One purpose of 7.14.5.1 is to find this:

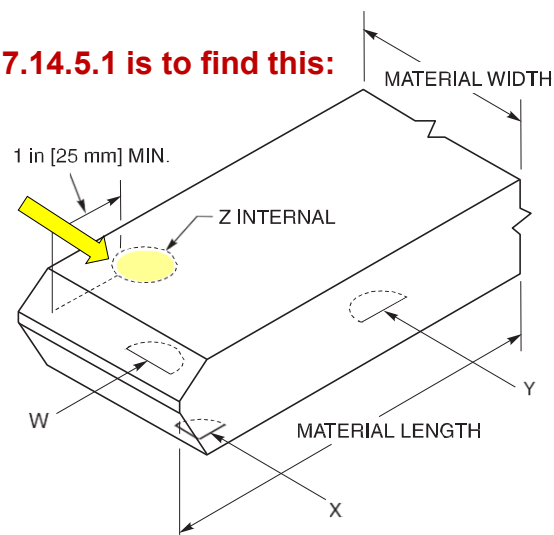


Figure 7.1—Edge Discontinuities in Cut Material



50

## AWS D1.1:2020 Structural Welding Code--Steel



(4) If the area of the discontinuity W, X, Y, or Z exceeds the allowable in 7.14.5.1(2), the cut material or subcomponent shall be rejected and replaced, or repaired **at the discretion of the Engineer.**



51

## AWS D1.1:2020 Structural Welding Code--Steel



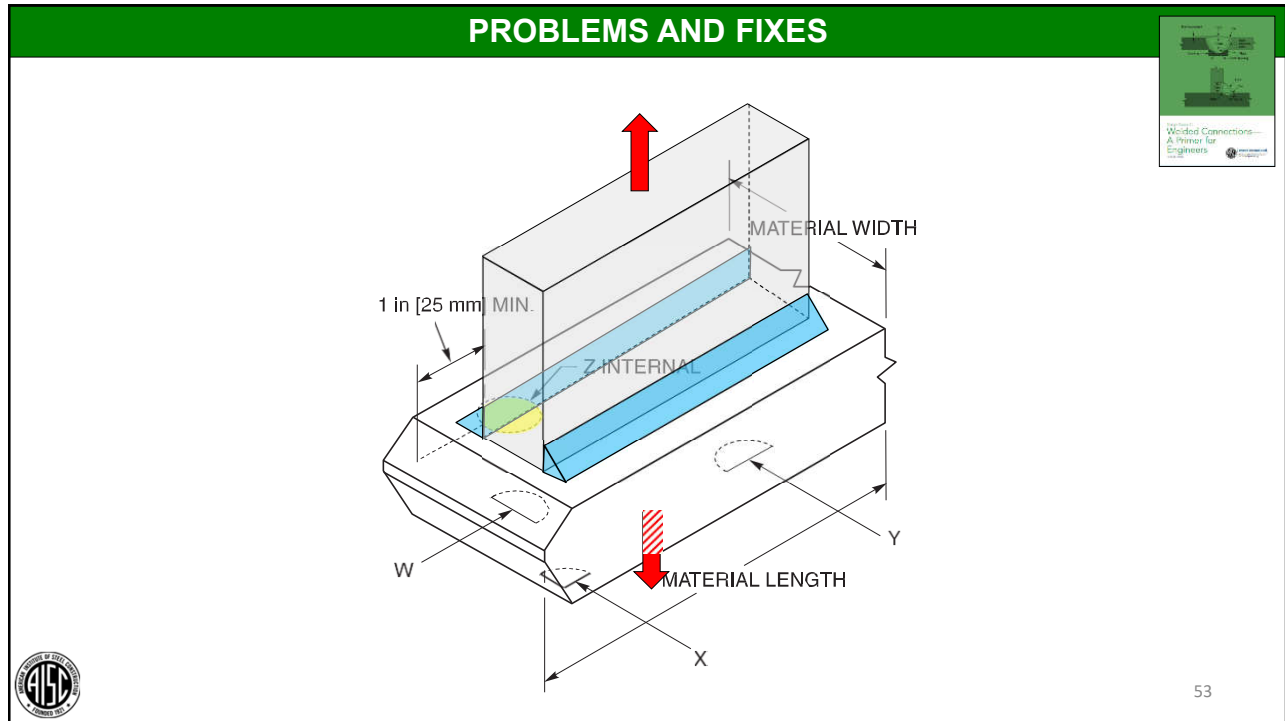
### 7.14.5.2 Repair.

In the repair and determination of limits of mill induced discontinuities visually observed on cut surfaces, the amount of metal removed shall be the minimum necessary to remove the discontinuity or to determine the limits of Table 7.4 are not exceeded. ...

**NOTE: The requirements of 7.14.5.2 may not be adequate in cases of tensile load applied through the thickness of the material.**



52



### PROBLEMS AND FIXES

#### Repairs to Cut Edges (Mill Induced): Summary

- Length and depth determine acceptability and permitted repairs
- Explore by grinding, not AAG
- Excessive inclusions may render the steel unacceptable

54

## PROBLEMS AND FIXES

### Chapter 15: Problems and Fixes

- 15.1 Repairs to Base Metal
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- 15.8 Repairs to Welds



55

## AWS D1.1:2020 Structural Welding Code--Steel

### 7.21.3 Butt Joint Alignment.


Parts to be joined at butt joints shall be carefully aligned. Where the parts are effectively restrained against bending due to eccentricity in alignment, the offset from the theoretical alignment shall not exceed 10% of the thickness of the thinner part joined, or 1/8 in [3 mm], whichever is smaller. In correcting misalignment in such cases, the parts shall not be drawn in to a greater slope than 1/2 in [12 mm] in 12 in [300 mm]. Measurement of offset shall be based upon the centerline of parts unless otherwise shown on the drawings.

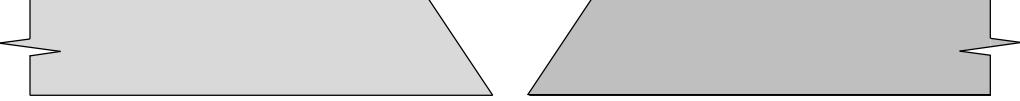
**1/2 in 12 = 1 in 24**




56

### PROBLEMS AND FIXES




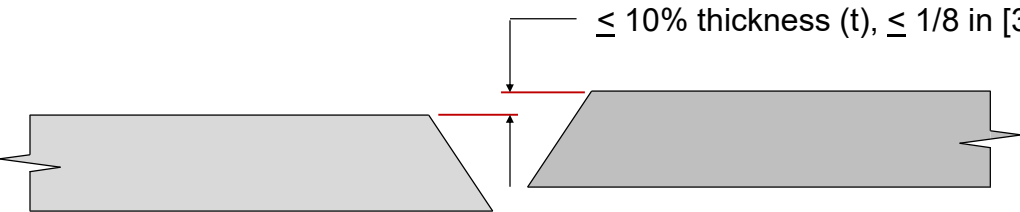


**Ideal**


57

### PROBLEMS AND FIXES

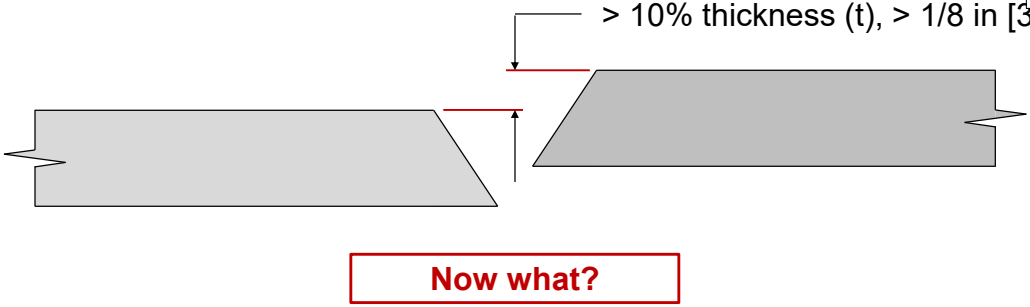






**Acceptable**

58

### PROBLEMS AND FIXES

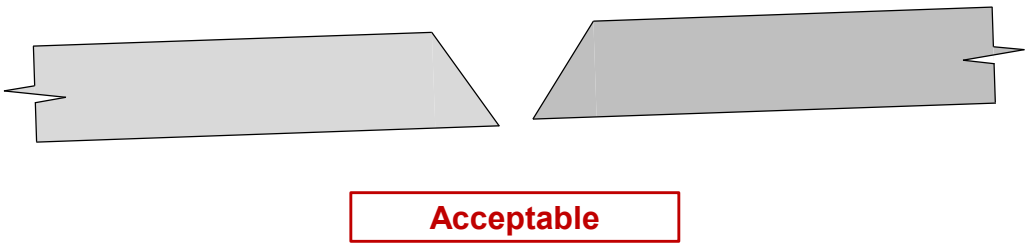


Now what?





59

### PROBLEMS AND FIXES



Acceptable



60


### PROBLEMS AND FIXES

The diagram shows two vertical plates overlapping. The top plates are separated by a gap, while the bottom plates are in contact. This represents a problem in a double shear lap joint.

The diagram shows two vertical plates overlapping. Both the top and bottom plates are separated by gaps, representing a problem in a double shear lap joint.

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61




### PROBLEMS AND FIXES

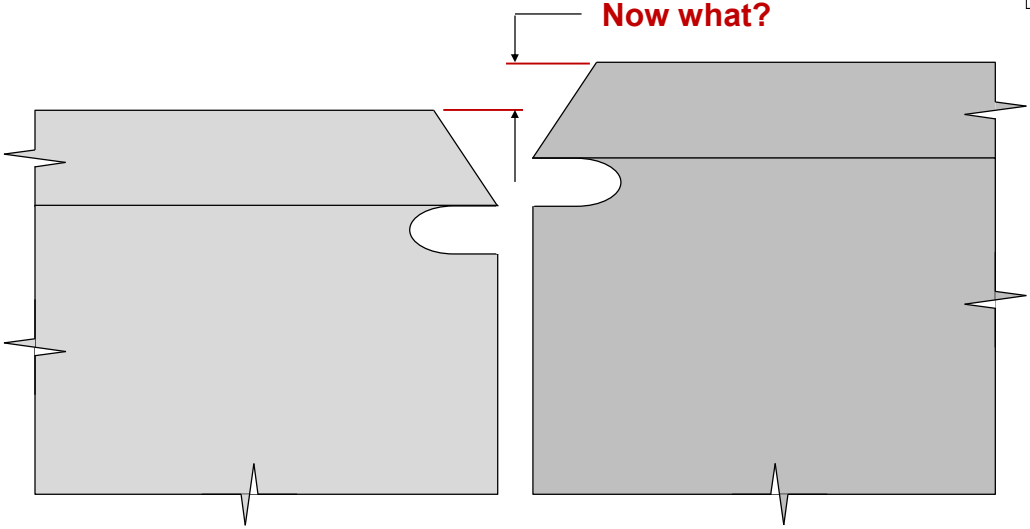
The diagram shows two vertical plates overlapping. Both the top and bottom plates are separated by gaps. A dimension line with arrows indicates the gap size between the top plates, with the text:  $\leq 10\% \text{ thickness } (t), \leq 1/8 \text{ in } [3 \text{ mm}]$ .

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62



### PROBLEMS AND FIXES



Now what?





63

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#### 8.8 Engineer's Approval for Alternate Acceptance Criteria


The fundamental premise of the code is to provide general stipulations applicable to most situations. Acceptance criteria for production welds different from those described in the code may be used for a particular application, provided they are suitably documented by the proposer and approved by the Engineer.

These alternate acceptance criteria may be based upon evaluation of suitability for service using past experience, experimental evidence or engineering analysis considering material type, service load effects, and environmental factors.

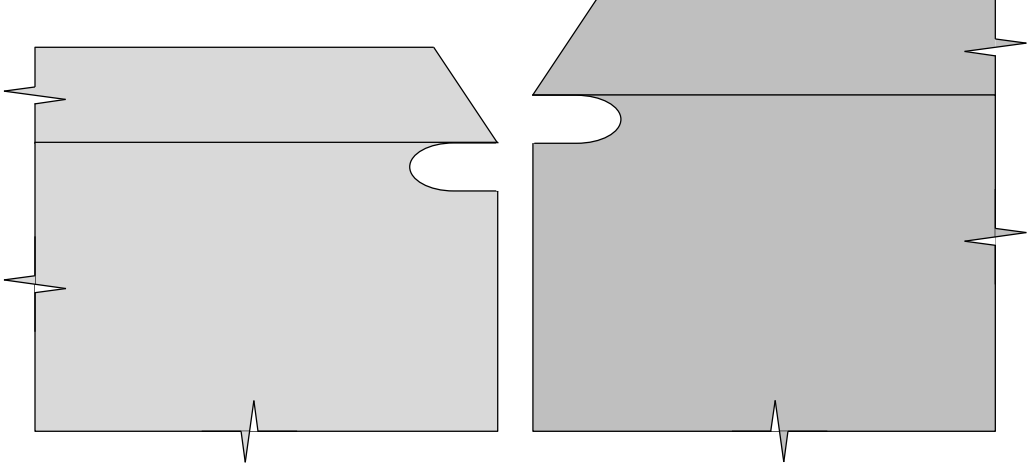



64

### PROBLEMS AND FIXES




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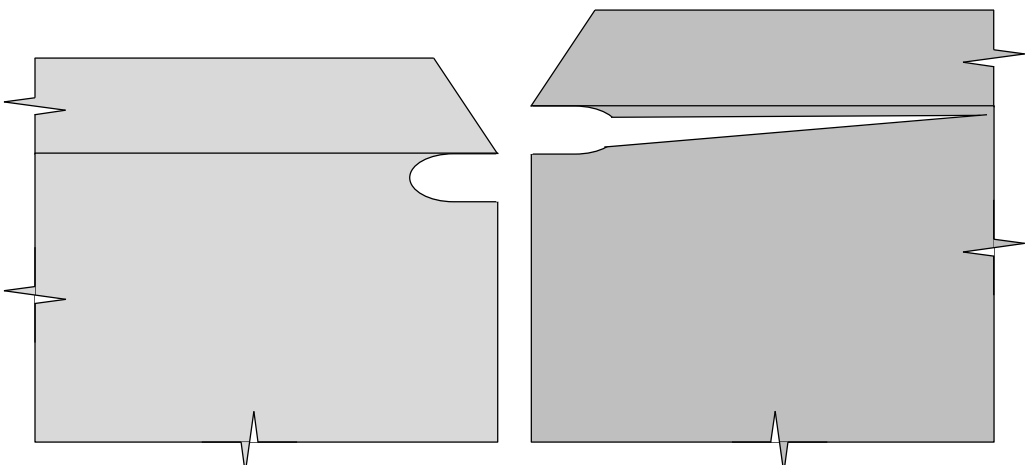



65

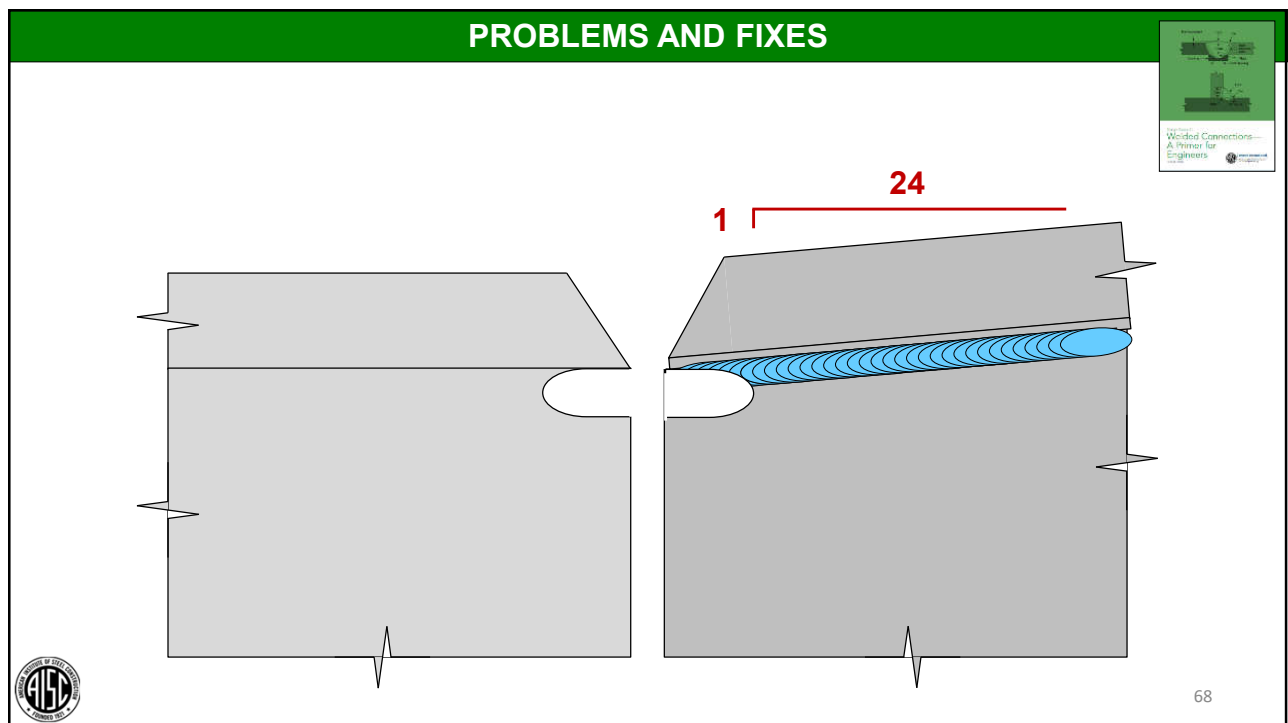
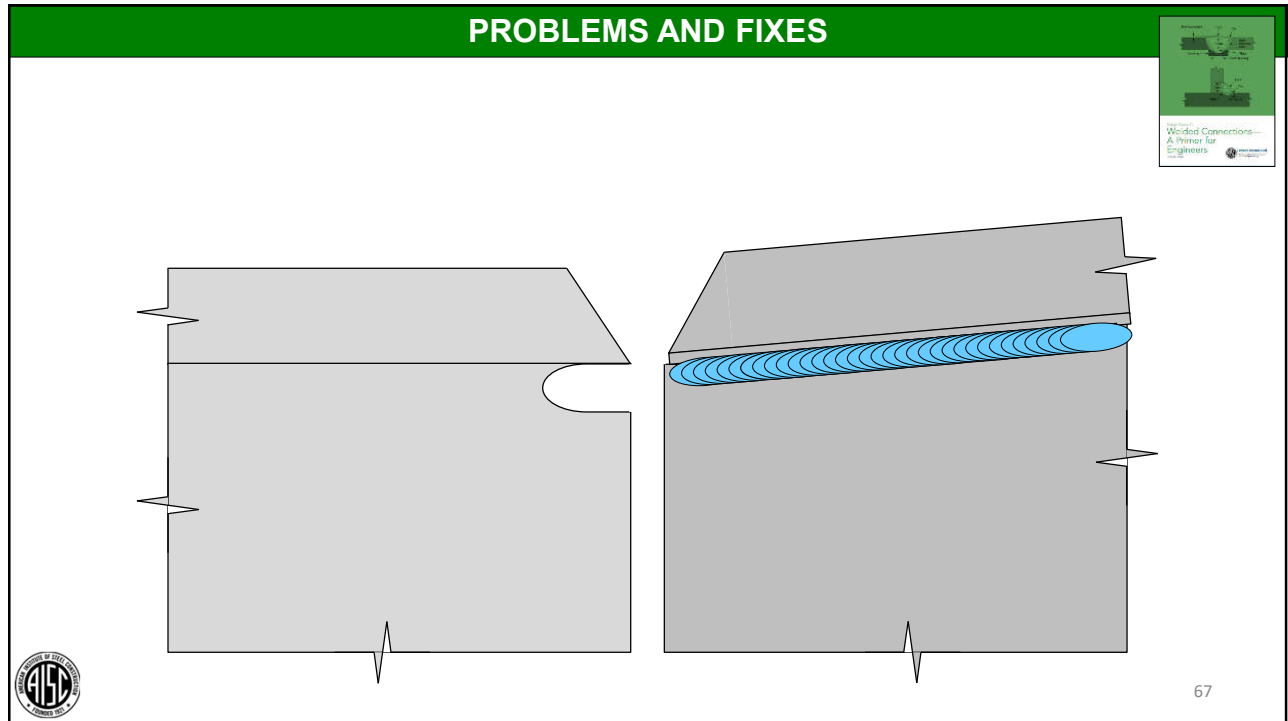
### PROBLEMS AND FIXES



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66



**PROBLEMS AND FIXES**

The diagram illustrates a cross-section of a steel beam with a 1 in 24 slope. A red dimension line indicates a slope of 1 unit vertical for every 24 units horizontal. The top surface of the beam is shaded blue, and the bottom surface is shaded grey. A hatched area represents the weld. To the right, a corresponding fix is shown, which is a rectangular block with a semi-circular notch on its top surface, matching the profile of the beam's top edge. The AISC logo is in the bottom left corner, and the number 69 is in the bottom right corner.


**PROBLEMS AND FIXES**

**1 in 24 ratio**

Offset	Length
1/4 in (6 mm)	6 in (150 mm)
1/2 in (12 mm)	12 in (300 mm)
3/4 in (18 mm)	18 in (450 mm)
1 in (25 mm)	24 in (600 mm)

The AISC logo is in the bottom left corner, and the number 70 is in the bottom right corner.

### AWS D1.1:2020 Structural Welding Code--Steel




#### 7.21.3 Butt Joint Alignment.


Parts to be joined at butt joints shall be carefully aligned. Where the parts are effectively restrained against bending due to eccentricity in alignment, the offset from the theoretical alignment shall not exceed 10% of the thickness of the thinner part joined, or 1/8 in [3 mm], whichever is smaller. In correcting misalignment in such cases, the parts shall not be drawn in to a greater slope than 1/2 in [12 mm] in 12 in [300 mm]. Measurement of offset shall be based upon the centerline of parts unless otherwise shown on the drawings.

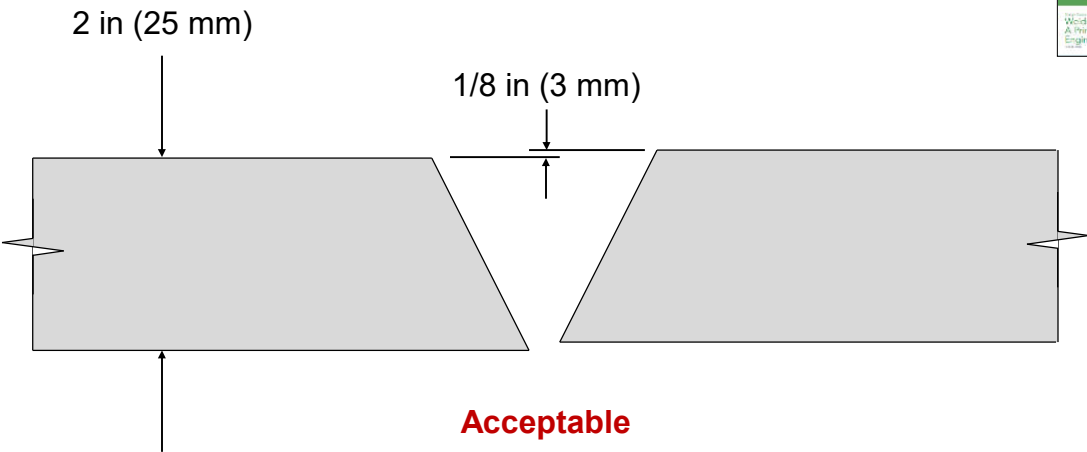
**1/2 in 12 = 1 in 24**

71




### PROBLEMS AND FIXES



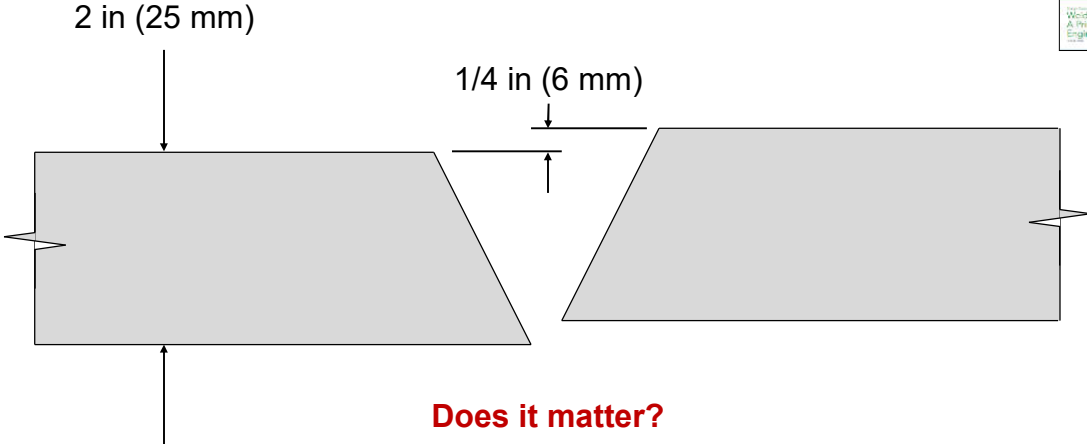


**Acceptable**

72




**PROBLEMS AND FIXES**



**Does it matter?**

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A Primer for  
Engineers




73

**PROBLEMS AND FIXES**

**15.3 Butt Joint Alignment: Summary**

- Code provides limits: smaller of 10% thickness or 1/8 in (3 mm)
- For restrained members, 1: 24 slope
- EOR could permit alternative criteria

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Engineers



74

**PROBLEMS AND FIXES**




**Chapter 15: Problems and Fixes**

- 15.1 Repairs to Base Metal
- 15.2 Repairs to Cut Edges
- 15.3 Butt Joint Alignment
- ➔ 15.4 Out-of-Tolerance Weld Joints
- 15.5 Fixing Members that are Cut Short
- 15.6 Repair of Mislocated Holes
- 15.7 Use of Plug Welds in Lieu of Bolts
- 15.8 Repairs to Welds




75

**PROBLEMS AND FIXES**



**15.4 Out-of-tolerance Weld Joints**

- 15.4.1 Sources of Fit-Up Variation
- ➔ 15.4.2 Fit-Up Problems with Fillet Welded Joints
- 15.4.3 Fit-Up Problems with CJP Groove Welded Joints
- 15.4.4 Fit-Up Problems with PJP Groove Welded Joints
- 15.4.5 Fit-Up Problems with Plug and Slot Welded Joints



76

## AWS D1.1:2020 Structural Welding Code--Steel

### 7.21.1 Fillet Weld Assembly.

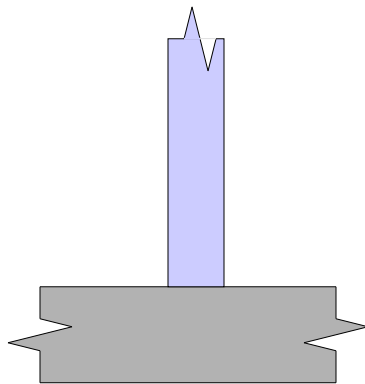
The parts to be joined by fillet welds shall be brought into as close contact as practicable. The root opening shall not exceed  $3/16$  in [5 mm] except in cases involving either shapes or plates 3 in [75 mm] or greater in thickness if, after straightening and in assembly, the root opening cannot be closed sufficiently to meet this tolerance... a maximum root opening of  $5/16$  in [8 mm] may be used, provided suitable backing is used.



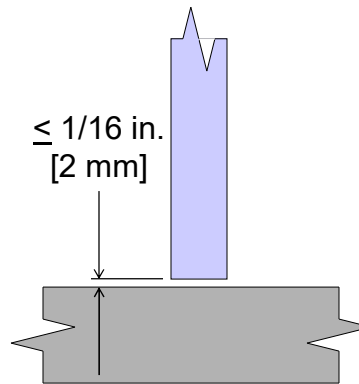
77

## PROBLEMS AND FIXES

Ideal




Permitted without correction

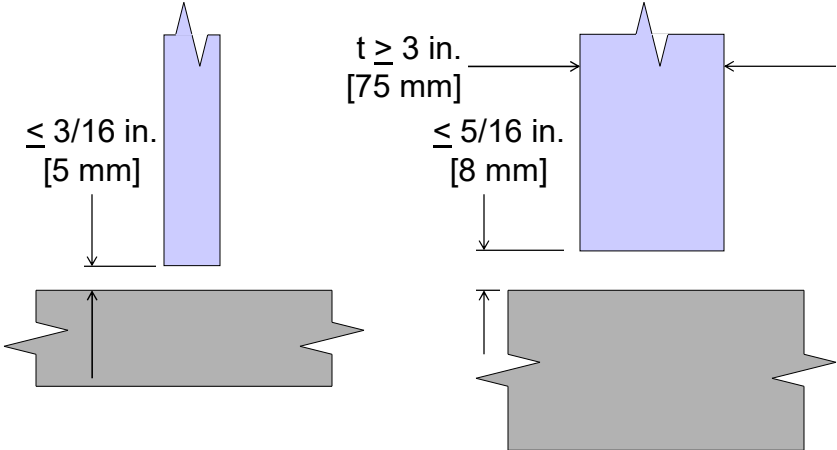


78

### PROBLEMS AND FIXES




#### Permitted with correction



$\leq 3/16$  in. [5 mm]


$t \geq 3$  in. [75 mm]

$\leq 5/16$  in. [8 mm]

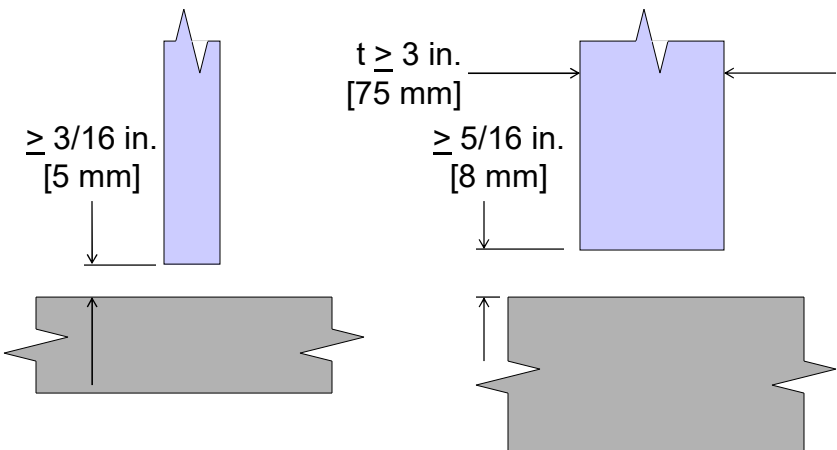


79

### PROBLEMS AND FIXES




#### Now what?



$\geq 3/16$  in. [5 mm]

$t \geq 3$  in. [75 mm]

$\geq 5/16$  in. [8 mm]



80

## AWS D1.1:2020 Structural Welding Code--Steel



### 8.8 Engineer's Approval for Alternate Acceptance Criteria

The fundamental premise of the code is to provide general stipulations applicable to most situations. Acceptance criteria for production welds different from those described in the code may be used for a particular application, provided they are suitably documented by the proposer and approved by the Engineer.

These alternate acceptance criteria may be based upon evaluation of suitability for service using past experience, experimental evidence or engineering analysis considering material type, service load effects, and environmental factors.

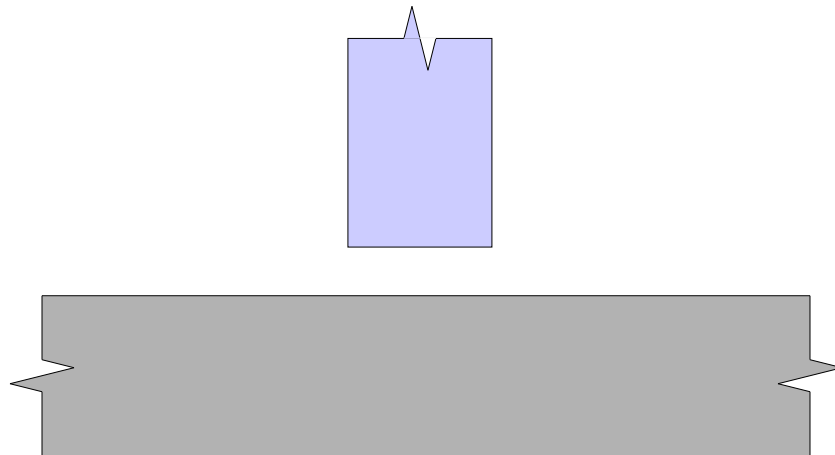


81

## PROBLEMS AND FIXES



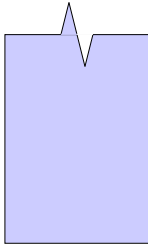
### Design Guide Option 1: Buttering





82

**PROBLEMS AND FIXES**

**Design Guide Option 1: Buttering**



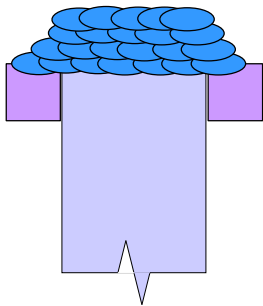






83

**PROBLEMS AND FIXES**

**Design Guide Option 1: Buttering**



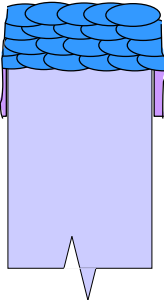






84

**PROBLEMS AND FIXES**

**Design Guide Option 1: Buttering**



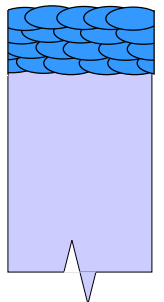
The diagram shows a vertical rectangular steel plate with a notch at the bottom. The top surface of the plate is covered with a blue, textured layer representing a buttered surface. The plate is light purple in color.





85

**PROBLEMS AND FIXES**

**Design Guide Option 1: Buttering**



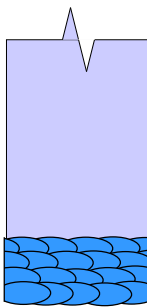
The diagram shows a vertical rectangular steel plate with a notch at the bottom. The top surface of the plate is covered with a blue, textured layer representing a buttered surface. The plate is light purple in color.





86

**PROBLEMS AND FIXES**

**Design Guide Option 1: Buttering**



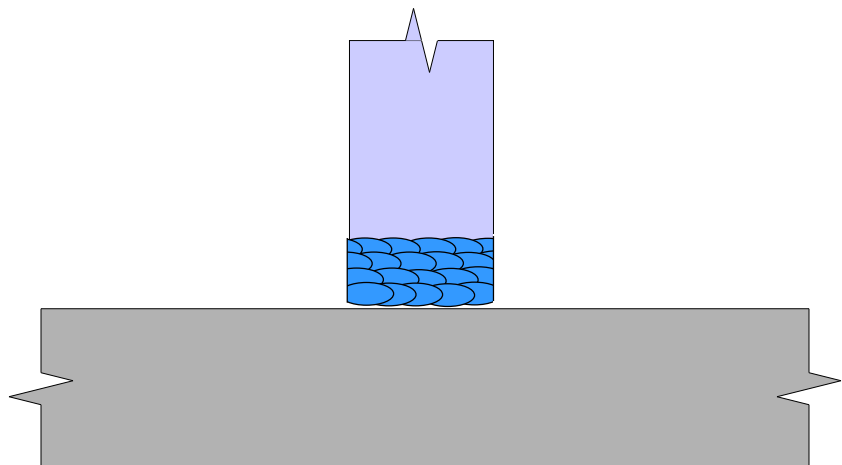
The diagram shows a vertical rectangular steel plate. At the top, there is a V-groove. The bottom portion of the plate is filled with a blue, wavy, textured layer representing a buttered surface. The rest of the plate is a solid light purple color.





87

**PROBLEMS AND FIXES**

**Design Guide Option 1: Buttering**



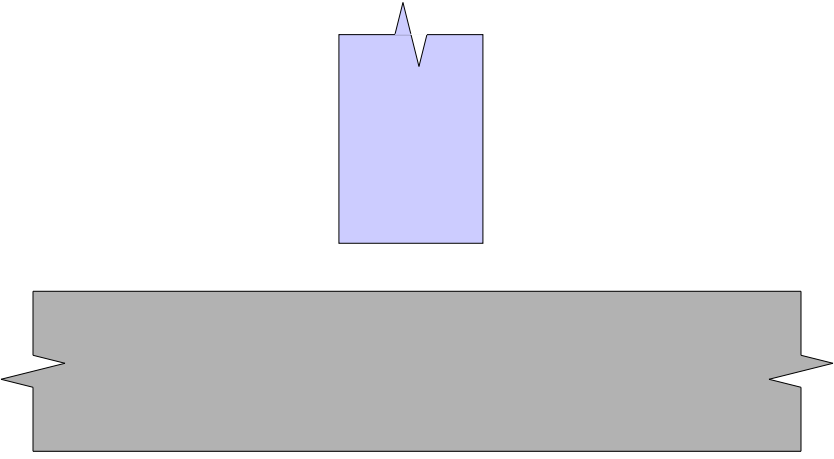
The diagram shows a vertical rectangular steel plate with a V-groove at the top. The bottom portion of the plate is filled with a blue, wavy, textured layer representing a buttered surface. This plate is positioned on top of a wider, grey base plate. The base plate has a jagged left edge and a jagged right edge, suggesting it is part of a larger assembly.





88

**PROBLEMS AND FIXES**

**Design Guide Option 2: Change to CJP groove weld**



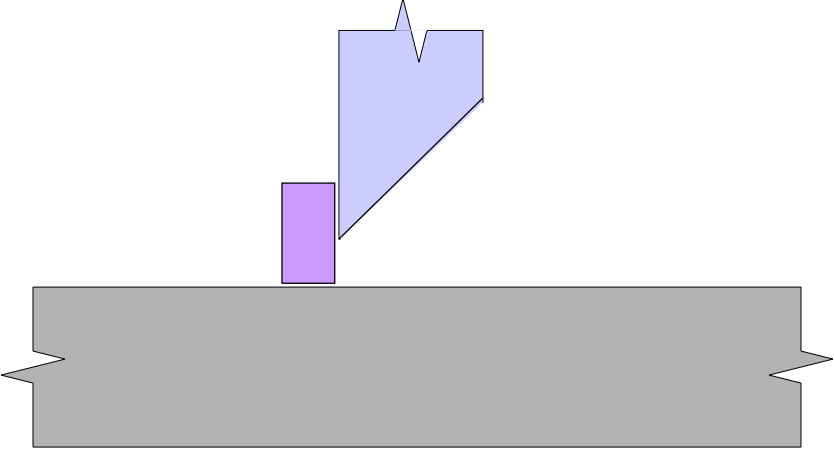
The diagram shows a cross-section of a groove weld joint. A light blue rectangular piece is positioned above a grey rectangular piece. The top surface of the grey piece has a V-shaped groove cut into it, and the light blue piece is seated within this groove. The joint is a continuous groove weld (CJP).





89

**PROBLEMS AND FIXES**

**Design Guide Option 2: Change to CJP groove weld**




The diagram shows a cross-section of a groove weld joint. A light blue rectangular piece is positioned above a grey rectangular piece. The top surface of the grey piece has a V-shaped groove cut into it, and the light blue piece is seated within this groove. A purple rectangular gusset is attached to the side of the light blue piece, extending downwards to the top surface of the grey piece.




90

**PROBLEMS AND FIXES**




**15.4 Out-of-tolerance Weld Joints**

- 15.4.1 Sources of Fit-Up Variation
- 15.4.2 Fit-Up Problems with Fillet Welded Joints
- ➔ 15.4.3 Fit-Up Problems with CJP Groove Welded Joints
- 15.4.4 Fit-Up Problems with PJP Groove Welded Joints
- 15.4.5 Fit-Up Problems with Plug and Slot Welded Joints


91


**PROBLEMS AND FIXES**




**15.4 Out-of-tolerance Weld Joints**

15.4.3 Fit-up Problems with CJP Groove Welded Joints

Prequalified Joint Details		Fitup Problem	
		Too Tight	Too Loose
Backing	Yes	X	X
	No	X	X


92


**PROBLEMS AND FIXES**




**15.4 Out-of-tolerance Weld Joints**

15.4.3 Fit-up Problems with CJP Groove Welded Joints

Prequalified Joint Details		Fitup Problem	
		Too Tight	Too Loose
Backing	Yes	X	X
	No	X	X


93


**PROBLEMS AND FIXES**




**15.4 Out-of-tolerance Weld Joints**

15.4.3 Fit-up Problems with CJP Groove Welded Joints

Prequalified Joint Details		Fitup Problem	
		Too Tight	Too Loose
<b>Backing</b>	Yes	X	X
	No	X	X


94


**PROBLEMS AND FIXES**




**15.4 Out-of-tolerance Weld Joints**

15.4.3 Fit-up Problems with CJP Groove Welded Joints

Prequalified Joint Details		Fitup Problem	
		Too Tight	Too Loose
<b>Backing</b>	Yes	X	X
	No	X	X


95

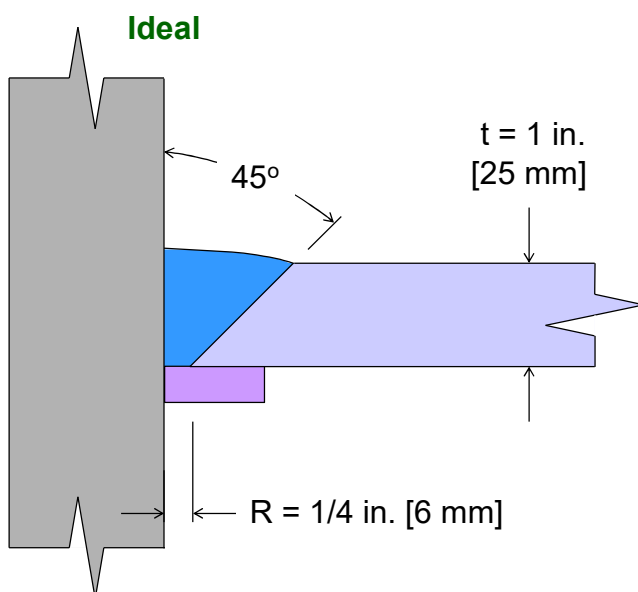
**PROBLEMS AND FIXES**




Weld volume:  
 3.08 lb/ft  
 [4.58 kg/m]

V = 1.0

**Ideal**




96

### PROBLEMS AND FIXES

Weld volume:  
 **$V = 1.6$**

**Permitted**

$55^\circ$

$t = 1 \text{ in. [25 mm]}$

$R = 1/2 \text{ in. [12 mm]}$

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Engineers

97

### PROBLEMS AND FIXES

Weld volume:  
 **$V = 1.57$**

**Outside Limits**

$45^\circ$

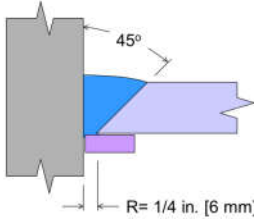
$t = 1 \text{ in. [25 mm]}$

$R = 3/4 \text{ in. [18 mm]}$

Welded Connections—  
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Engineers

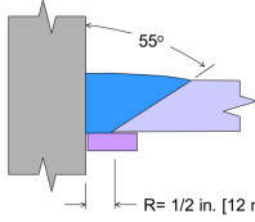
98

### PROBLEMS AND FIXES



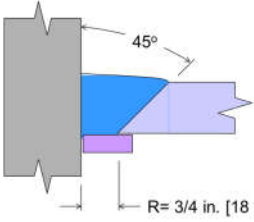
$\alpha = 45^\circ$   
 $R = 1/4 \text{ in. [6 mm]}$

**Ideal**  
 $\alpha = 45^\circ$   
 $R = 1/4 \text{ in.}$   
 $V/L = 1.0$




$\alpha = 55^\circ$   
 $R = 1/2 \text{ in. [12 mm]}$


**Permitted**  
 $\alpha = 55^\circ$   
 $R = 1/2 \text{ in.}$   
 $V/L = 1.60$



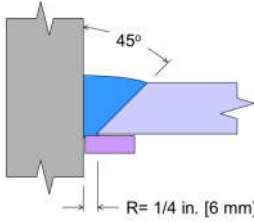
$\alpha = 45^\circ$   
 $R = 3/4 \text{ in. [18 mm]}$

**Outside Limits**  
 $\alpha = 45^\circ$   
 $R = 3/4 \text{ in.}$   
 $V/L = 1.57$

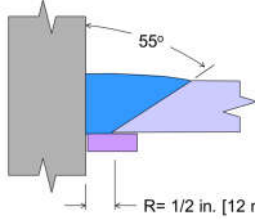



99

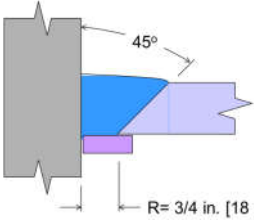
### PROBLEMS AND FIXES



$\alpha = 45^\circ$   
 $R = 1/4 \text{ in. [6 mm]}$




$\alpha = 55^\circ$   
 $R = 1/2 \text{ in. [12 mm]}$




$\alpha = 45^\circ$   
 $R = 3/4 \text{ in. [18 mm]}$

**DG 21 Suggestion:**

If the volume of weld metal required to weld the joint that is outside limits is less than what is permitted for similar joints with allowed tolerances, the EOR can approve welding of the joint without correction.




100

## AWS D1.1:2020 Structural Welding Code--Steel



### 7.21.4.2 Correction.

Root openings greater than those allowed in 7.21.4.1, but not greater than twice the thickness of the thinner part or 3/4 in [20 mm], whichever is less, may be corrected by welding to acceptable dimensions prior to joining the parts by welding.

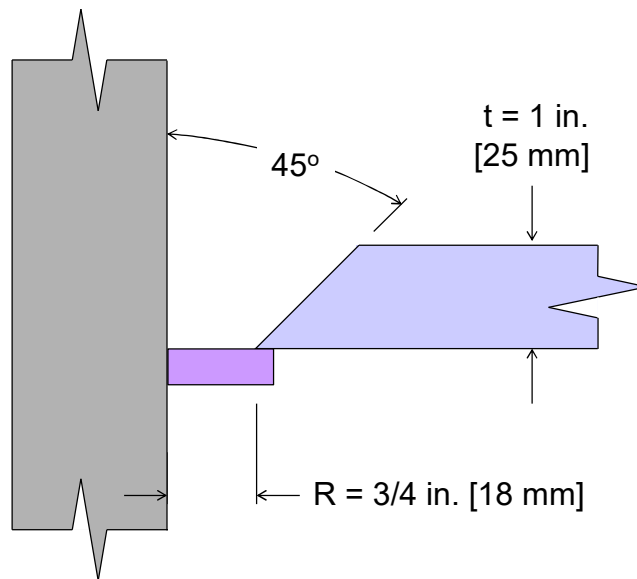


101

## PROBLEMS AND FIXES




Outside general limits,  
within clause 5.21.4.2





102

**PROBLEMS AND FIXES**

**Outside general limits, within clause 5.21.4.2**




The diagram shows a light blue steel plate with a jagged, irregular edge on the right side, representing a problem with a weld. The plate has a trapezoidal shape on the left that tapers to a point, then widens and ends in a jagged, non-uniform edge.





103

**PROBLEMS AND FIXES**

**Outside general limits, within clause 5.21.4.2**




The diagram shows a light blue steel plate with a beveled edge on the left side, representing a fix for a weld. The plate has a trapezoidal shape on the left that tapers to a point, then widens and ends in a jagged, non-uniform edge. The left edge is now beveled with several overlapping blue circles representing weld ripples.



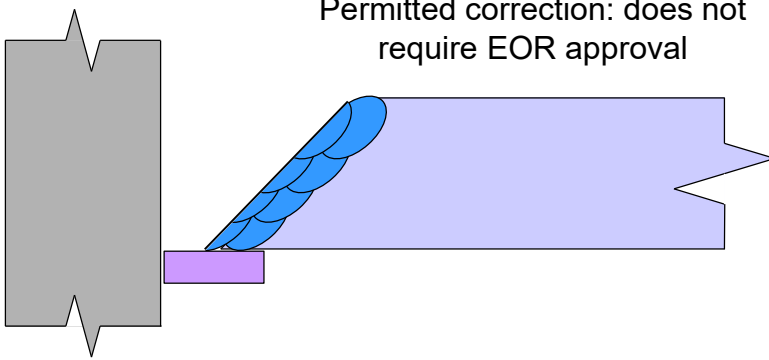
104


### PROBLEMS AND FIXES




**Outside general limits, within clause 5.21.4.2**

Permitted correction: does not require EOR approval




105

### AWS D1.1:2020 Structural Welding Code--Steel



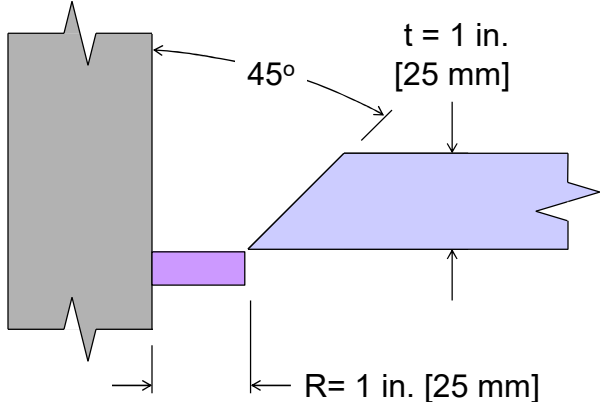
**7.21.4.3 Engineer's Approval.**

Root openings greater than allowed by 7.21.4.2 may be corrected by welding only with the approval of the Engineer.

106

**PROBLEMS AND FIXES**

**Outside general limits, outside limits of clause 5.21.4.2**

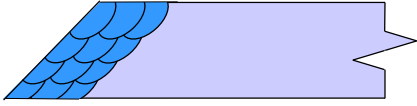


The diagram shows a grey steel plate on the left with a 45-degree chamfered edge. A purple fillet weld connects this edge to a blue steel plate on the right. The blue plate has a thickness  $t = 1 \text{ in. [25 mm]}$  and a fillet weld with a radius  $R = 1 \text{ in. [25 mm]}$ . A small inset image in the top right corner shows a book cover titled "Welded Connections—A Primer for Engineers".

107

**PROBLEMS AND FIXES**


**Outside general limits, outside limits of clause 5.21.4.2**



The diagram shows a blue steel plate with a scalloped weld toe on its left end. A small inset image in the top right corner shows a book cover titled "Welded Connections—A Primer for Engineers".

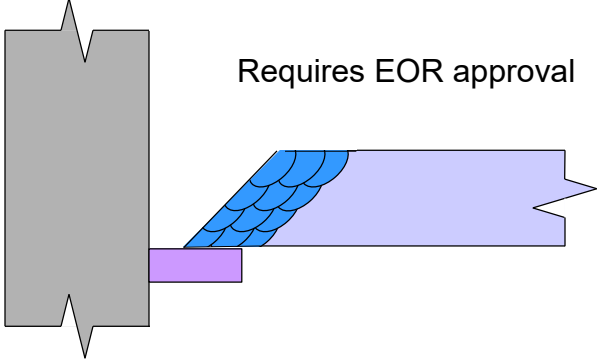
108


### PROBLEMS AND FIXES




**Outside general limits, outside limits of clause 5.21.4.2**

Requires EOR approval

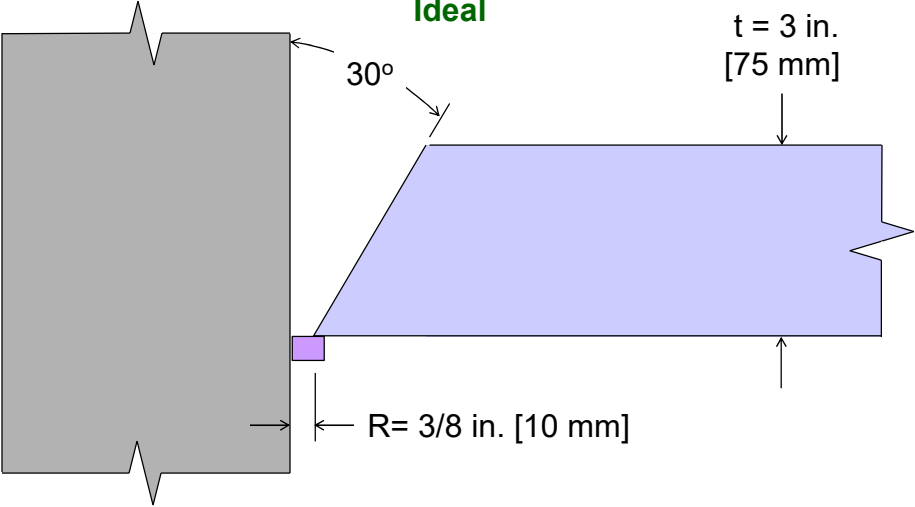


109

### PROBLEMS AND FIXES




**Ideal**



$t = 3 \text{ in. [75 mm]}$

$30^\circ$

$R = 3/8 \text{ in. [10 mm]}$

110

### PROBLEMS AND FIXES

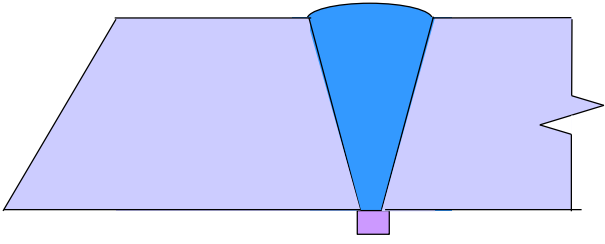
The diagram shows a grey steel plate on the left with a 30-degree chamfered edge. A purple fillet weld is applied to the chamfered surface. The weld has a radius  $R = 1\frac{1}{2}$  in. [40 mm]. The thickness of the steel plate is  $t = 3$  in. [75 mm]. The chamfer angle is labeled as  $30^\circ$ . The relationship  $R = t/2$  is indicated in green text. A small inset in the top right corner shows a book cover titled "Welded Connections—A Primer for Engineers". The AISC logo is in the bottom left, and the number 111 is in the bottom right.


### PROBLEMS AND FIXES


The diagram shows a grey steel plate on the left with a chamfered edge. A blue fillet weld, labeled "Butter Option", is applied to the chamfered surface. The weld has a radius of  $\text{Butter} = 1\frac{1}{8}$  in. [28 mm]. The thickness of the steel plate is  $t = 3$  in. [75 mm]. A small inset in the top right corner shows a book cover titled "Welded Connections—A Primer for Engineers". The AISC logo is in the bottom left, and the number 112 is in the bottom right.

**PROBLEMS AND FIXES**

**Splice Option**



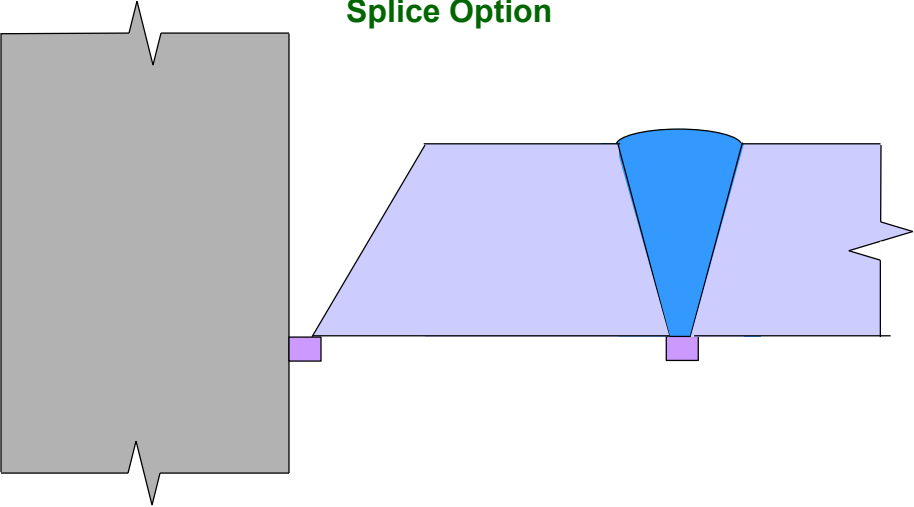






113

**PROBLEMS AND FIXES**

**Splice Option**






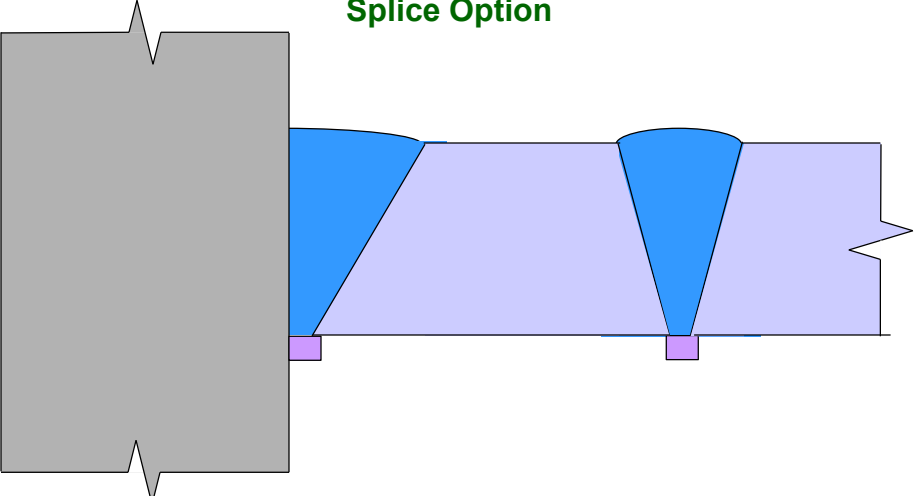



114

### PROBLEMS AND FIXES



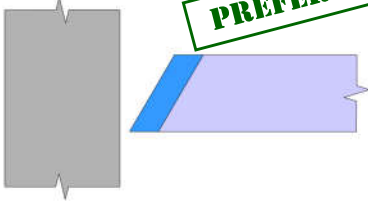
## Splice Option



115

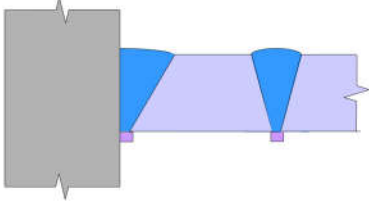
### PROBLEMS AND FIXES

## Butter Option




**PREFERRED**


## Splice Option



- Both require EOR approval
- Both require similar amounts of welding
- Buttering is a simpler solution

116


**PROBLEMS AND FIXES**




**15.4 Out-of-tolerance Weld Joints**

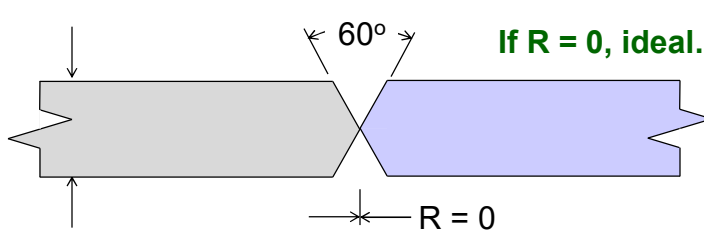
15.4.3 Fit-up Problems with CJP Groove Welded Joints

Prequalified Joint Details		Fitup Problem	
		Too Tight	Too Loose
<b>Backing</b>	Yes	X	X
	No	X	X


117

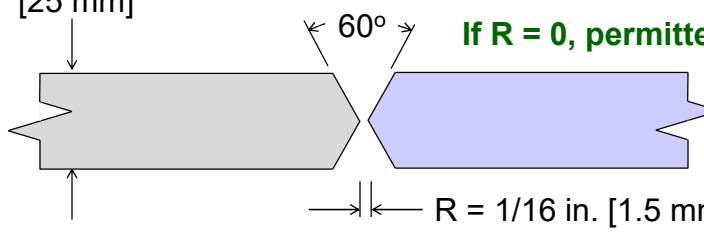
**PROBLEMS AND FIXES**






$t = 1 \text{ in.}$   
 $[25 \text{ mm}]$

$R = 0$



$R = 1/16 \text{ in.} [1.5 \text{ mm}]$




118

### PROBLEMS AND FIXES

**If  $R = 0$ , ideal.**

**If  $R = 0$ , outside limits.**

*(Note: The diagram shows a 60-degree bevel angle and a root opening of R = 0 for the ideal case, and R = 1/8 in. [3 mm] for the case outside limits. The thickness t = 1 in. [25 mm] is indicated for the top plate.)*





119

### AWS D1.1:2020 Structural Welding Code--Steel

**7.21.4.2 Correction.**

Root openings greater than those allowed in 7.21.4.1, but not greater than twice the thickness of the thinner part or 3/4 in [20 mm], whichever is less, may be corrected by welding to acceptable dimensions prior to joining the parts by welding.



120

### PROBLEMS AND FIXES

**Ideal**

$60^\circ$



$R = 0$

$t = 1 \text{ in. [25 mm]}$

**Within limits of 5.22.4.2**

$60^\circ$

$R = 3/4 \text{ in. [18 mm]}$



121

### PROBLEMS AND FIXES

**Ideal**

$60^\circ$



$R = 0$

$t = 1 \text{ in. [25 mm]}$

**Outside limits of 5.22.4.2**

$60^\circ$

$R = 1 \text{ in. [25 mm]}$



122

**PROBLEMS AND FIXES**



**Butter**  
(requires EOR approval)

**Outside limits of 5.21.4.2**

$t = 1 \text{ in.}$   
 $[25 \text{ mm}]$

$60^\circ$

$R = 1 \text{ in.}$   $[25 \text{ mm}]$



123

**PROBLEMS AND FIXES**



**Insert**  
(requires EOR approval)

**Outside limits of 5.21.4.2**

$t = 1 \text{ in.}$   
 $[25 \text{ mm}]$

$60^\circ$

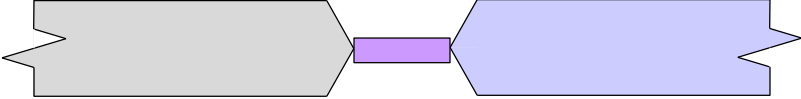
$R = 1 \text{ in.}$   $[25 \text{ mm}]$





124

**PROBLEMS AND FIXES**

**Insert**  
(requires EOR approval)



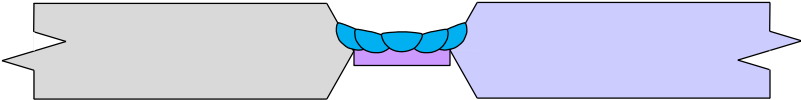
The diagram shows two steel plates, one grey on the left and one light blue on the right, with a gap between them. A purple rectangular insert is placed in the gap, touching the inner surfaces of both plates. The plates have jagged ends on the outer sides.





125

**PROBLEMS AND FIXES**

**Insert**  
(requires EOR approval)



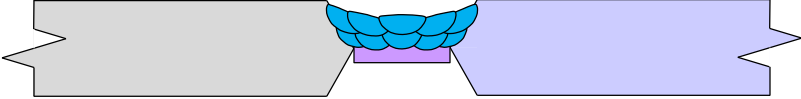
The diagram shows the same two steel plates and purple insert as in the previous slide. A blue weld bead is applied over the purple insert, joining the two plates together.





126

**PROBLEMS AND FIXES**

**Insert**  
(requires EOR approval)



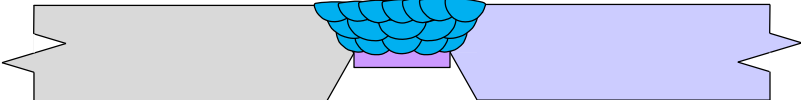
The diagram shows a cross-section of a steel-to-steel connection. On the left is a grey steel member with a jagged end. On the right is a light blue steel member with a jagged end. A purple rectangular insert is positioned between the two members. A blue, textured weld bead is applied over the top surface of the insert, joining the two steel members.





127

**PROBLEMS AND FIXES**

**Insert**  
(requires EOR approval)



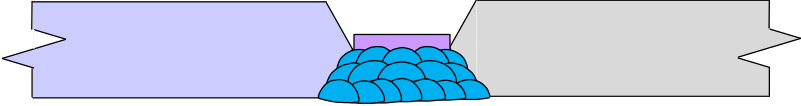
The diagram shows a cross-section of a steel-to-steel connection, identical to the one on slide 127. It features a grey steel member on the left and a light blue steel member on the right, joined by a purple insert and a blue weld bead.





128

**PROBLEMS AND FIXES**

**Insert**  
(requires EOR approval)

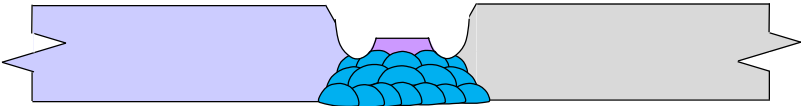




 

129

**PROBLEMS AND FIXES**

**Insert**  
(requires EOR approval)

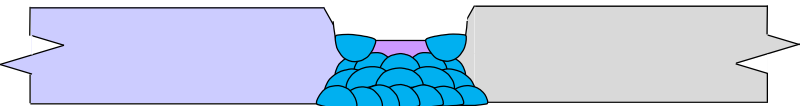



 

130


**PROBLEMS AND FIXES**

**Insert**  
(requires EOR approval)



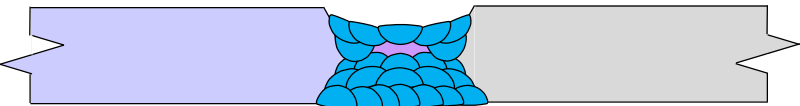



131




**PROBLEMS AND FIXES**

**Insert**  
(requires EOR approval)



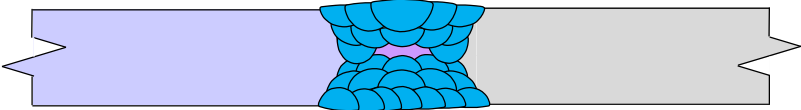



132




## PROBLEMS AND FIXES

**Insert**  
(requires EOR approval)



  
Welded Connections—  
A Primer for  
Engineers





133

## PROBLEMS AND FIXES

### 15.4 Out-of-Tolerance Weld Joints: Summary

- The code provides limits, primarily based on workmanship
- The code provides solutions for problems, within limits
- The EOR can extend those limits
- DG21 provides alternatives the EOR can consider

  
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A Primer for  
Engineers



134

**PROBLEMS AND FIXES**




**Chapter 15: Problems and Fixes**

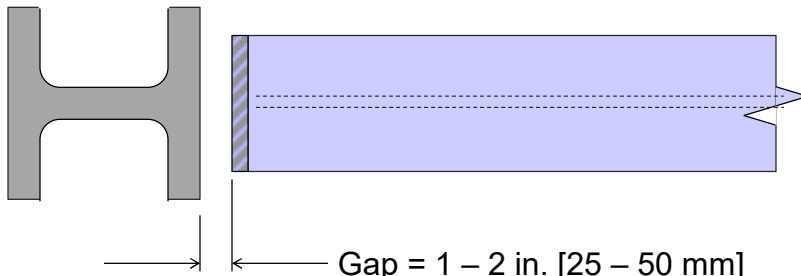
- 15.1 Repairs to Base Metal
- 15.2 Repairs to Cut Edges
- 15.3 Butt Joint Alignment
- 15.4 Out-of-Tolerance Weld Joints
- ➔ 15.5 Fixing Members that are Cut Short**
- 15.6 Repair of Mislocated Holes
- 15.7 Use of Plug Welds in Lieu of Bolts
- 15.8 Repairs to Welds

 135

**PROBLEMS AND FIXES**




**15.5 Fixing Members That Are Cut Short**



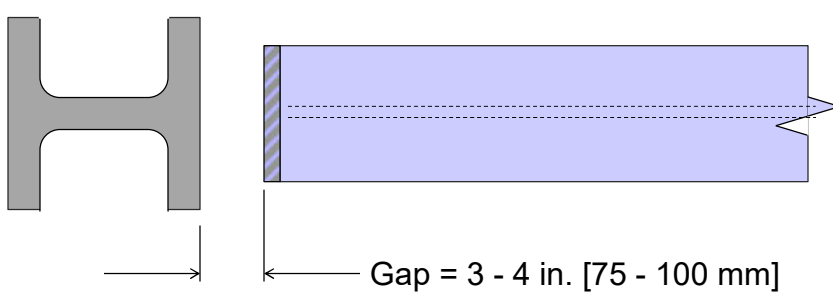
Gap = 1 – 2 in. [25 – 50 mm]

**Buttering may be a good solution**

 136

**PROBLEMS AND FIXES**



**15.5 Fixing Members That Are Cut Short**



The diagram shows a grey H-beam on the left and a blue rectangular fixing member on the right. A gap of 3 to 4 inches (75 to 100 mm) is indicated between the end of the beam and the start of the fixing member. A dashed line represents the centerline of the beam.

Gap = 3 - 4 in. [75 - 100 mm]

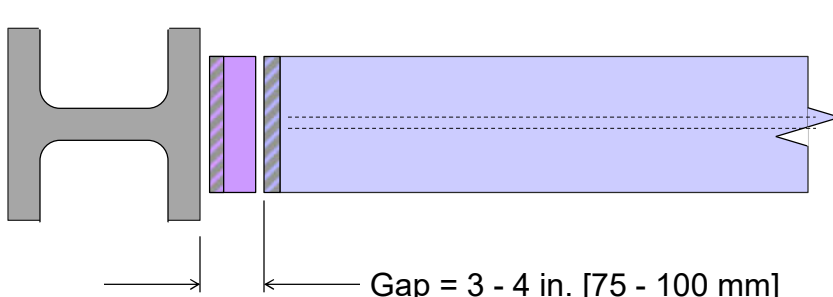
**Buttering probably not a good solution**



137

**PROBLEMS AND FIXES**




**15.5 Fixing Members That Are Cut Short**



The diagram shows a grey H-beam on the left and a blue rectangular fixing member on the right. A gap of 3 to 4 inches (75 to 100 mm) is indicated between the end of the beam and the start of the fixing member. A purple rectangular insert is shown between the beam and the fixing member. A dashed line represents the centerline of the beam.

Gap = 3 - 4 in. [75 - 100 mm]

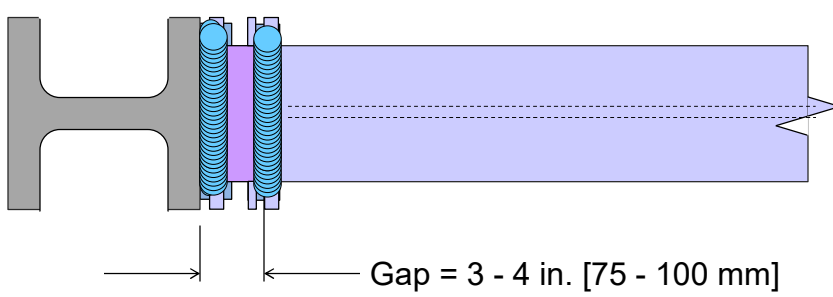
**Use an insert?**



138



**PROBLEMS AND FIXES**

**15.5 Fixing Members That Are Cut Short**



Gap = 3 - 4 in. [75 - 100 mm]

**Use an insert?**

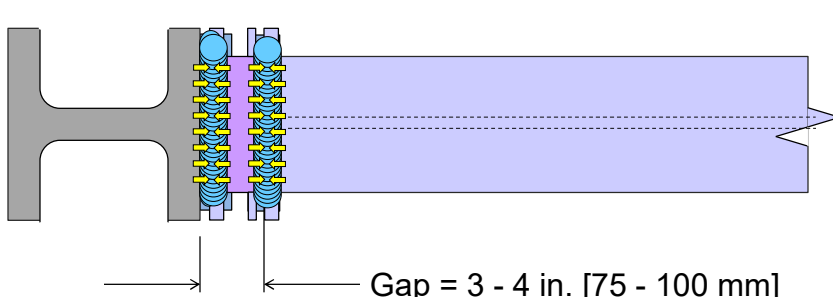


139

Welded Connections—  
A Primer for  
Engineers



**PROBLEMS AND FIXES**

**15.5 Fixing Members That Are Cut Short**



Gap = 3 - 4 in. [75 - 100 mm]

**Use an insert?**

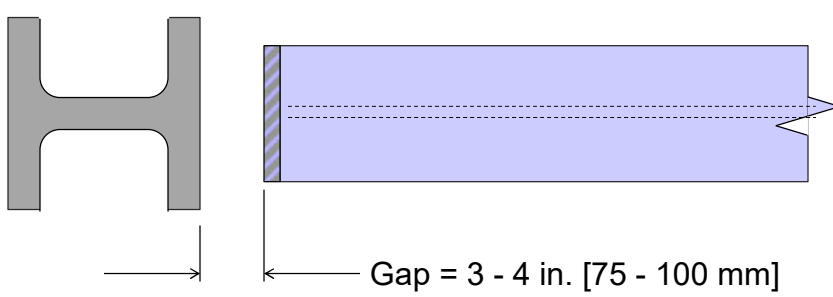


140



Welded Connections—  
A Primer for  
Engineers

**PROBLEMS AND FIXES**

**15.5 Fixing Members That Are Cut Short**



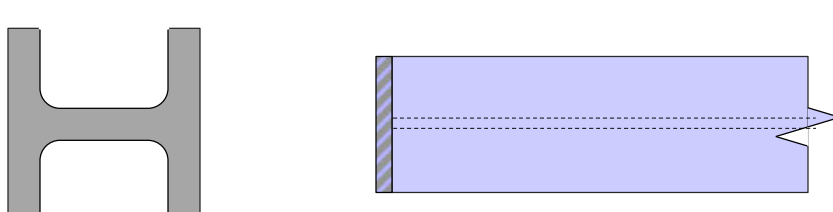
**Install a larger insert**





141

**PROBLEMS AND FIXES**

**15.5 Fixing Members That Are Cut Short**



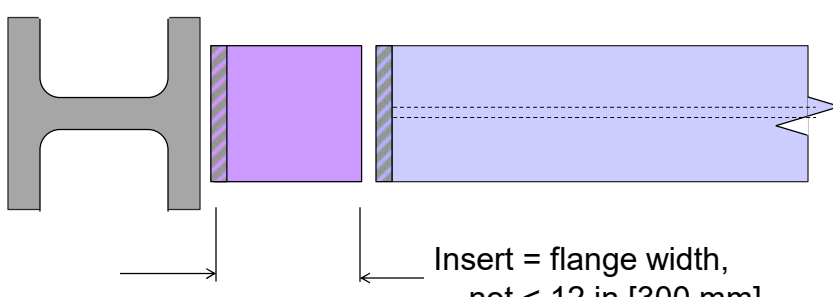
**DG suggestion: install a larger insert**



142



### PROBLEMS AND FIXES

## 15.5 Fixing Members That Are Cut Short



Insert = flange width,  
not < 12 in [300 mm]

**DG suggestion: install a larger insert**





143

### AWS D1.1:2020 Structural Welding Code--Steel

## 7.12 Conformance with Design

The sizes and lengths of welds shall be no less than those specified by design requirements and detail drawings, except as allowed in Table 8.1 or Table 10.16. The location of welds shall not be changed without approval of the Engineer.



144

## PROBLEMS AND FIXES



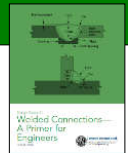
### 15.5 Fixing Members that are Cut Short

- Buttering may be an option (EOR must approve)
- Using an insert may be an option (EOR must approve)
- DG21 advise: make insert flange width or 12 in [300 mm] minimum to separate the two parallel welds



145

## PROBLEMS AND FIXES

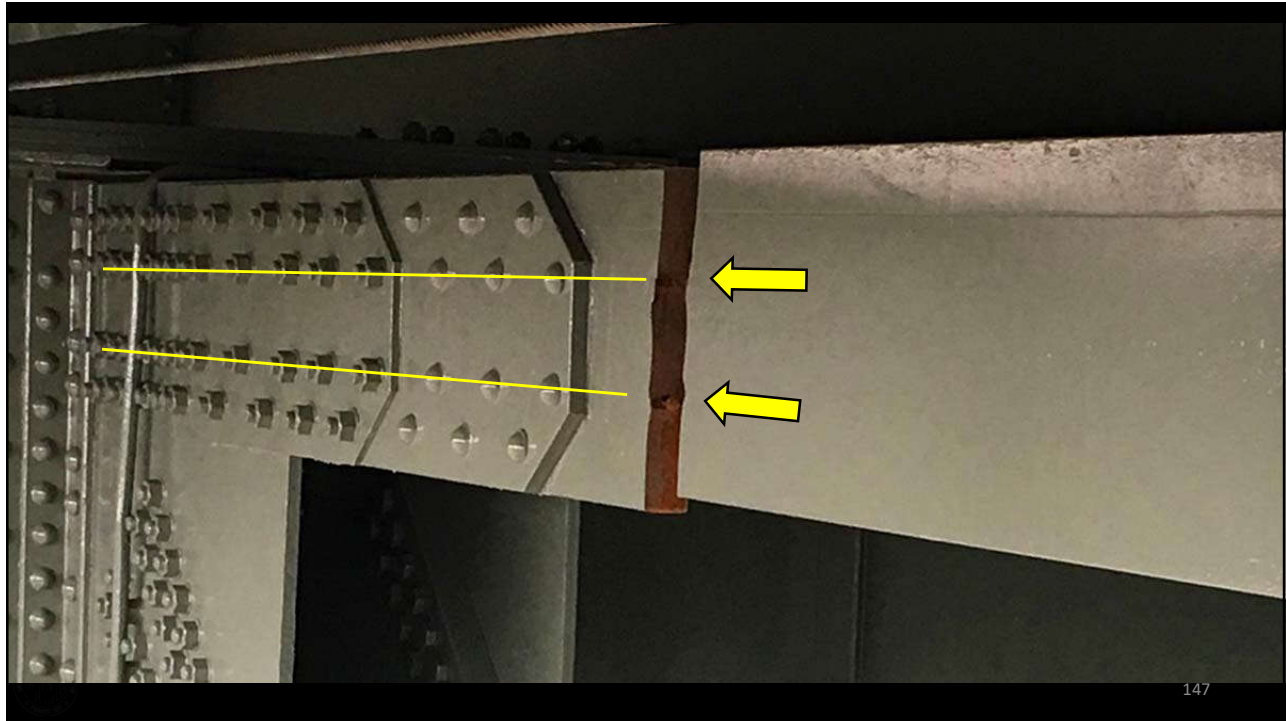


### Chapter 15: Problems and Fixes

- 15.1 Repairs to Base Metal
- 15.2 Repairs to Cut Edges
- 15.3 Butt Joint Alignment
- 15.4 Out-of-Tolerance Weld Joints
- 15.5 Fixing Members that are Cut Short
- ➔ 15.6 Repair of Mislocated Holes
- 15.7 Use of Plug Welds in Lieu of Bolts
- 15.8 Repairs to Welds



146



## AWS D1.1:2020 Structural Welding Code--Steel



### 7.25.5 Welded Restoration of Base Metal with Mislocated Holes.

Mislocated holes may be left open or filled with bolts except when welding is necessary to fulfill contract requirements or when require by the engineer. Base metal with mislocated holes may be restored by welding provided the Contractor prepares and follows a qualified or prequalified WPS and meeting the requirements of (1) through (4) below. The geometry shall be considered prequalified.

- 





148

**AWS D1.1:2020 Structural Welding Code--Steel**

**C-7.25.5 Welded Restoration of Base Metal with Mislocated Holes.**

The following may be found useful when addressing mislocated holes:



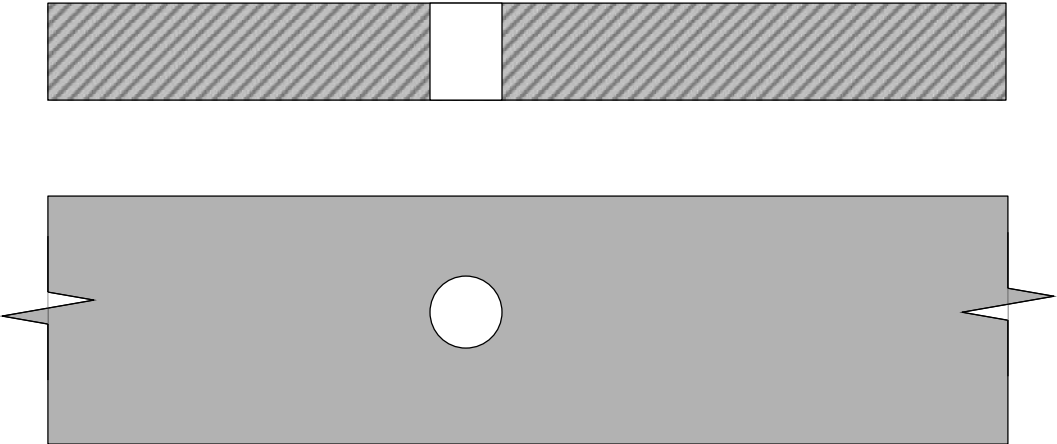
(two approaches follow)



149

**PROBLEMS AND FIXES**

**First approach**





150

**PROBLEMS AND FIXES**

**First approach**

The diagram illustrates a bolted connection. The top part shows a cross-section of a bolt and nut with a gap between them. The bottom part shows a side view of a plate with a hole and a bolt passing through it.





151

**PROBLEMS AND FIXES**

**First approach**

The diagram illustrates a bolted connection. The top part shows a cross-section of a bolt and nut with a gap between them. The bottom part shows a side view of a plate with a hole and a bolt passing through it.





152

**PROBLEMS AND FIXES**

**First approach**

The diagram shows a cross-section of a T-joint where a vertical purple stem is welded to a horizontal grey flange. A single blue fillet weld is applied to the top surface of the stem. Below this, a top-down view shows a blue circular weld pool on a grey rectangular plate, enclosed in a dashed square box with jagged ends on the left and right sides.





153

**PROBLEMS AND FIXES**

**First approach**

The diagram shows a cross-section of a T-joint where a vertical purple stem is welded to a horizontal grey flange. Two blue fillet welds are applied to the top and bottom surfaces of the stem. Below this, a top-down view shows a blue circular weld pool on a grey rectangular plate, enclosed in a dashed square box with jagged ends on the left and right sides.





154

**PROBLEMS AND FIXES**

**First approach**

The diagram illustrates a 'First approach' to a problem. The top part shows a cross-section of a beam with a blue weld on top and a purple plate below it. The bottom part shows a plan view of a beam with a blue circular hole, outlined with a dashed line.





155

**PROBLEMS AND FIXES**

**First approach**

The diagram illustrates a 'First approach' to a problem. The top part shows a cross-section of a beam with a blue weld on top. The bottom part shows a plan view of a beam with a blue circular hole filled with diagonal hatching.


Note: new in D1.1:2020, not in DG21




156

**PROBLEMS AND FIXES**

**Second approach**







157

**PROBLEMS AND FIXES**

**Second approach**







158

**PROBLEMS AND FIXES**

**Second approach**

The diagram illustrates a cross-section of a weld joint. The top part shows two grey hatched plates with a purple weld metal in the center. The bottom part shows a grey base metal with a purple weld bead in the center, surrounded by a grey oval shape. The weld bead is wider than the weld metal in the cross-section.





159

**PROBLEMS AND FIXES**

**Second approach**

The diagram illustrates a cross-section of a weld joint. The top part shows two grey hatched plates with a purple weld metal in the center. The bottom part shows a grey base metal with a purple weld bead in the center, surrounded by a grey oval shape. The weld bead is wider than the weld metal in the cross-section.



160

**PROBLEMS AND FIXES**

**Second approach**

Welded Connections—  
A Primer for  
Engineers

161

**PROBLEMS AND FIXES**

**Second approach**


Welded Connections—  
A Primer for  
Engineers

162

**PROBLEMS AND FIXES**

**Second approach**

Welded Connections—  
A Primer for  
Engineers




163

**PROBLEMS AND FIXES**

**Second approach**

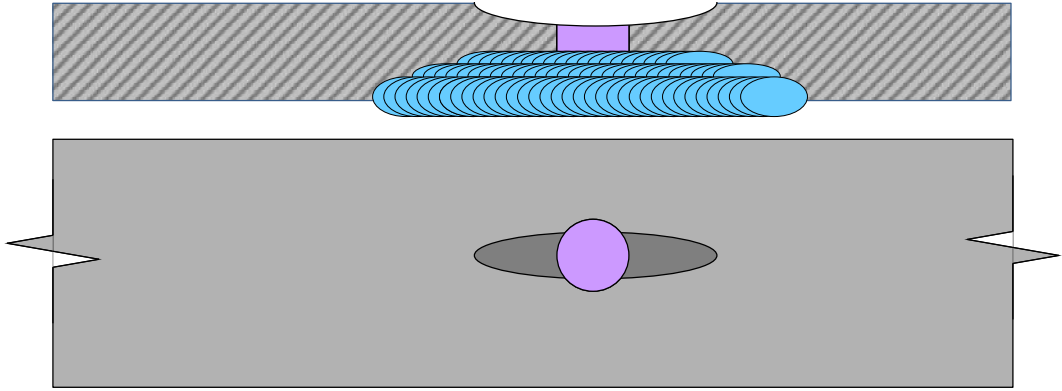
Welded Connections—  
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Engineers





164

**PROBLEMS AND FIXES**

**Second approach**



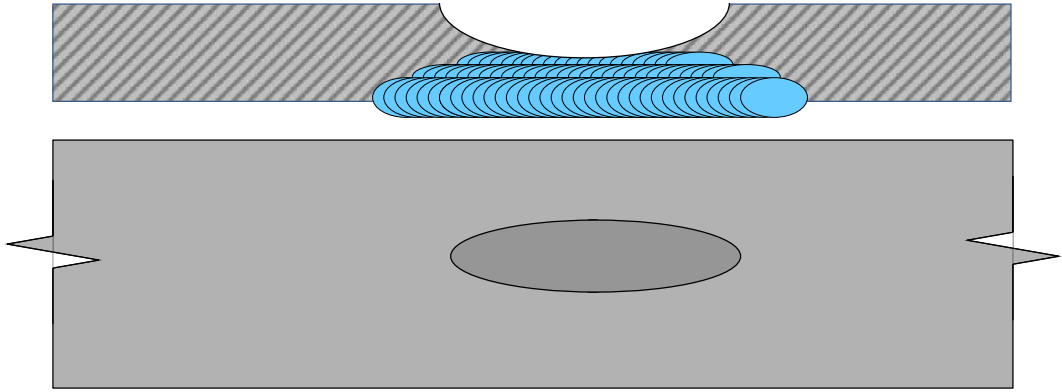
The diagram shows a cross-section of a weld joint. The top part is a hatched steel plate with a concave groove. A weld is applied to the groove, shown as a series of blue semi-circles. A purple rectangular defect is located at the center of the weld. Below this, a grey rectangular plate is shown with a purple oval defect in its center. Two jagged lines on the left and right sides of the grey plate indicate it is a section of a larger structure.





165

**PROBLEMS AND FIXES**

**Second approach**



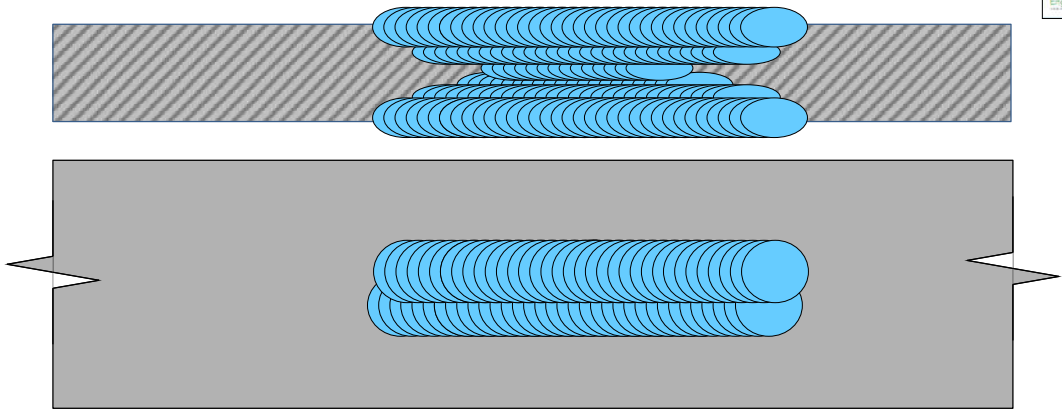
The diagram shows a cross-section of a weld joint. The top part is a hatched steel plate with a concave groove. A weld is applied to the groove, shown as a series of blue semi-circles. A purple rectangular defect is located at the center of the weld. Below this, a grey rectangular plate is shown with a purple oval defect in its center. Two jagged lines on the left and right sides of the grey plate indicate it is a section of a larger structure.





166

**PROBLEMS AND FIXES**

**Second approach**



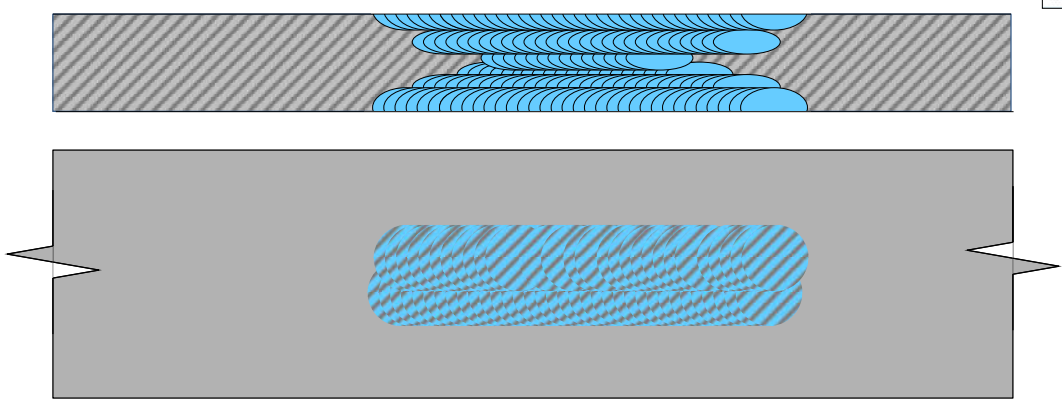






167

**PROBLEMS AND FIXES**

**Second approach**







168

## AWS D1.1:2020 Structural Welding Code--Steel



### 7.25.5 Welded Restoration of Base Metal with Mislocated Holes.

Mislocated holes may be left open or filled with bolts except when welding is necessary to fulfill contract requirements or when require by the engineer. Base metal with mislocated holes may be restored by welding provided the Contractor prepares and follows a qualified or prequalified WPS and meeting the requirements of (1) through (4) below. The geometry shall be considered prequalified.

•



169

## PROBLEMS AND FIXES



### 15.6 Repair of Mislocated Holes: Summary

- Caution: improperly repaired holes have been a problem, particularly for cyclically loaded structures
- Leaving the hole unfilled, or inserting a bolt, are good options
- If a weld repair is required, carefully follow code requirements and commentary recommendations



170

**PROBLEMS AND FIXES**




**Chapter 15: Problems and Fixes**

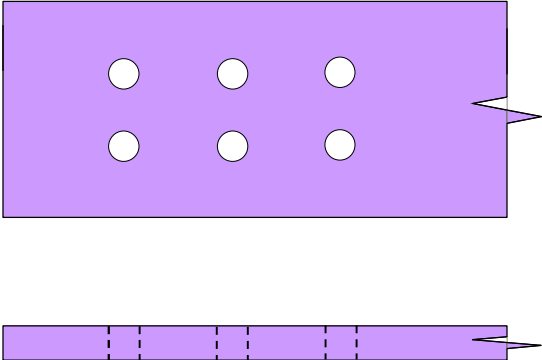
- 15.1 Repairs to Base Metal
- 15.2 Repairs to Cut Edges
- 15.3 Butt Joint Alignment
- 15.4 Out-of-Tolerance Weld Joints
- 15.5 Fixing Members that are Cut Short
- 15.6 Repair of Mislocated Holes
- 15.7 Use of Plug Welds in Lieu of Bolts**
- 15.8 Repairs to Welds


 171

**PROBLEMS AND FIXES**



**15.7 Use Of Plug Welds In Lieu Of Bolts**




 172

**PROBLEMS AND FIXES**

**15.7 Use Of Plug Welds In Lieu Of Bolts**

Welded Connections—  
A Primer for  
Engineers




173

**PROBLEMS AND FIXES**


**15.7 Use Of Plug Welds In Lieu Of Bolts**

Welded Connections—  
A Primer for  
Engineers




174

## PROBLEMS AND FIXES




### Concerns with plug welds

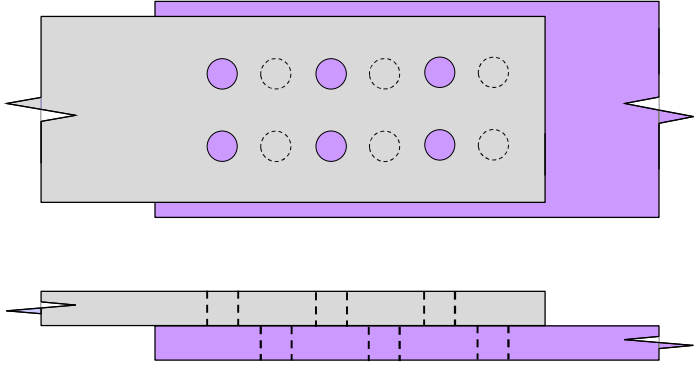
- Original hole was not optimized for plug welding
- Plug weld does not have the capacity of a high strength bolt
- Welding position must be considered; only flat position plug welds are easily made
- For cyclically loaded connections, plug welds have poor fatigue performance (Category E, F)
- Plug welds are assumed to be loaded in shear
- Bolted connection limit states may be different than plug welded connection limit states


175

## PROBLEMS AND FIXES




### Drill new holes and install more bolts




176

**PROBLEMS AND FIXES**

**Drill new holes and install more bolts**




177




**PROBLEMS AND FIXES**

**Drill new holes and install more bolts**



178



**PROBLEMS AND FIXES**

**Weld hole and re-drill**

The diagram illustrates a weld hole in a steel plate. The top part shows a cross-section of a grey steel plate with a purple weld bead on the right side. A hole has been drilled through the plate, but the weld metal has filled the hole. The bottom part shows the same plate after the hole has been re-drilled, with the weld metal removed and the hole restored to its original size. The AISC logo is in the bottom left, and the page number 179 is in the bottom right.

179

**PROBLEMS AND FIXES**

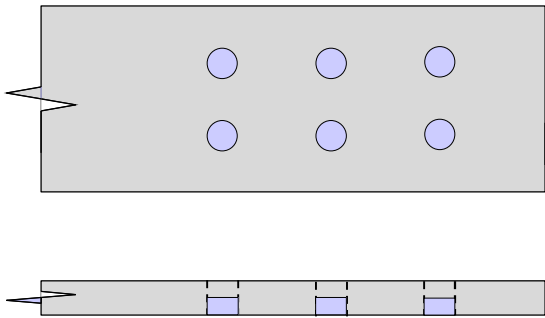
**Weld hole and re-drill**

The diagram illustrates a weld hole in a steel plate. The top part shows a cross-section of a grey steel plate with a hole that has been drilled through it. The bottom part shows the same plate after the hole has been re-drilled, with the hole restored to its original size. The AISC logo is in the bottom left, and the page number 180 is in the bottom right.



180

**PROBLEMS AND FIXES**

**Weld hole and re-drill**



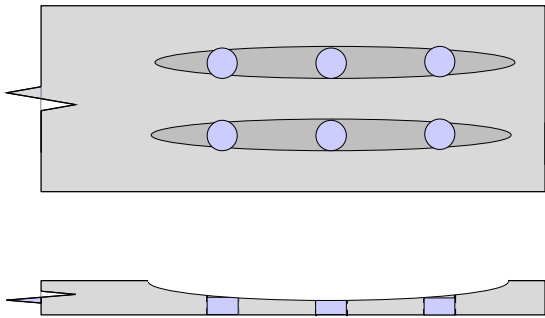
The diagram illustrates the process of re-drilling a weld hole. The top part shows a rectangular steel plate with a jagged edge on the left. It contains two rows of three circular holes each. The bottom part shows a cross-section of the plate with three rectangular welds connecting the two rows of holes. The welds are shown in a light blue color.





181

**PROBLEMS AND FIXES**

**Weld hole and re-drill**



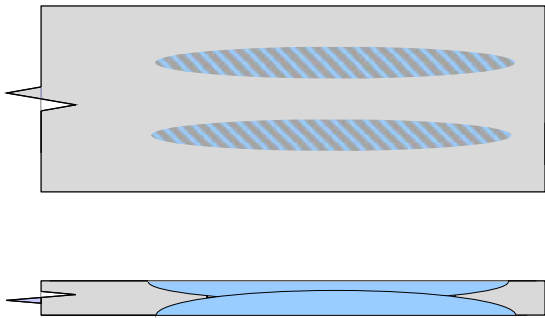
The diagram illustrates the process of re-drilling a weld hole. The top part shows a rectangular steel plate with a jagged edge on the left. It contains two rows of three circular holes each. The bottom part shows a cross-section of the plate with three rectangular welds connecting the two rows of holes. The welds are shown in a light blue color.





182

**PROBLEMS AND FIXES**

**Weld hole and re-drill**



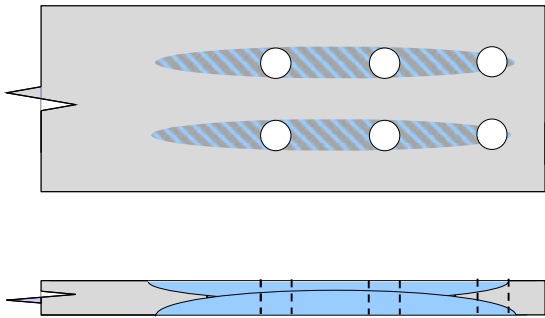
The diagram illustrates the repair of a weld hole in a steel plate. The top part shows a cross-section of a plate with a weld joint. A jagged, irregular hole has formed in the weld metal. The bottom part shows the same cross-section after the hole has been re-drilled into a smooth, cylindrical shape. The original weld metal is shown with blue diagonal hatching, and the re-drilled area is shown with a solid blue fill.





183

**PROBLEMS AND FIXES**

**Weld hole and re-drill**




The diagram illustrates the repair of a weld hole in a steel plate with three bolts. The top part shows a cross-section of a plate with a weld joint. A jagged, irregular hole has formed in the weld metal, and three bolts are shown passing through the plate. The bottom part shows the same cross-section after the hole has been re-drilled into a smooth, cylindrical shape. The original weld metal is shown with blue diagonal hatching, and the re-drilled area is shown with a solid blue fill. Dashed lines indicate the original positions of the bolts.




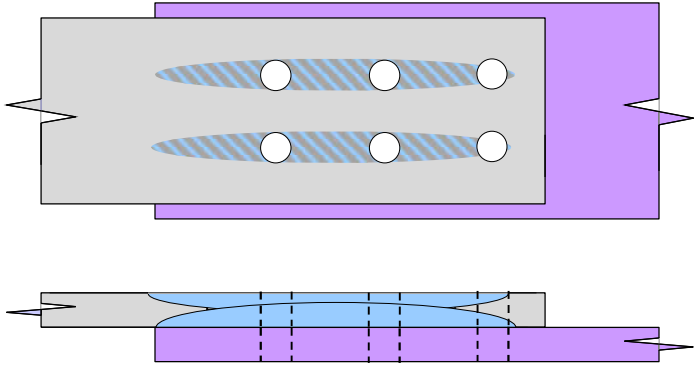
184

### PROBLEMS AND FIXES




Welded Connections—  
A Primer for  
Engineers

### Weld hole and re-drill




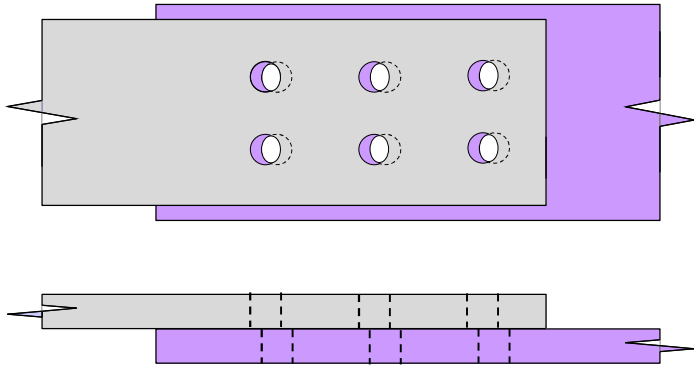
185

### PROBLEMS AND FIXES




Welded Connections—  
A Primer for  
Engineers

### Drill oversized holes and install larger bolts




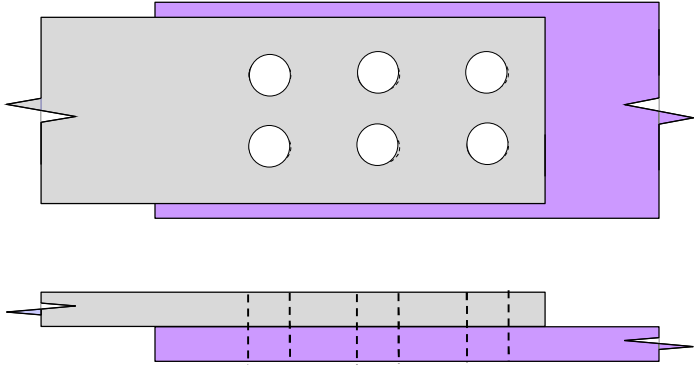
186

### PROBLEMS AND FIXES




Welded Connections—  
A Primer for  
Engineers

### Drill oversized holes and install larger bolts




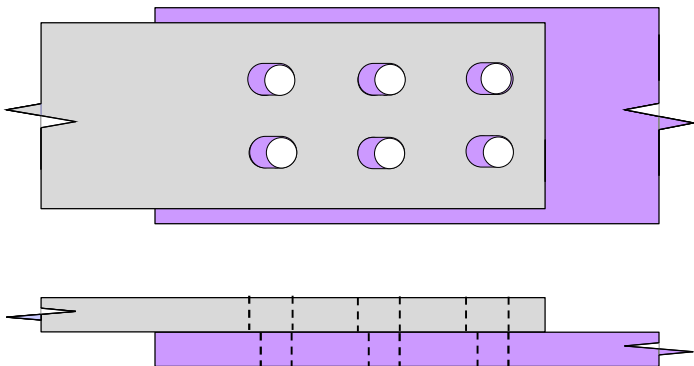
187

### PROBLEMS AND FIXES



Welded Connections—  
A Primer for  
Engineers

### Convert holes into slots



188

## PROBLEMS AND FIXES



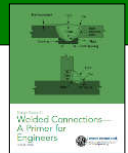
### 15.7 Use of Plug Welds in Lieu of Bolts: Summary

- Plug welds and bolts do not have the same capacity
- Bolt hole sizes are not optimized for plug welding
- Many mechanical options (but, probably more difficult to perform in the field as compared to a plug weld)



189

## PROBLEMS AND FIXES



- 15.9 Heat Shrinking of Q&T Steel
- 15.10 Unspecified Welds
- 15.11 Welds Made Without Inspection
- ➔ 15.12 Welding on Anchor Rods
- 15.13 Welding Anchor Rod to Base Plates
- 15.14 Removing And Reinstalling Column Base Plates
- 15.15 Repairing Lamellar Tears





190

**PROBLEMS AND FIXES**



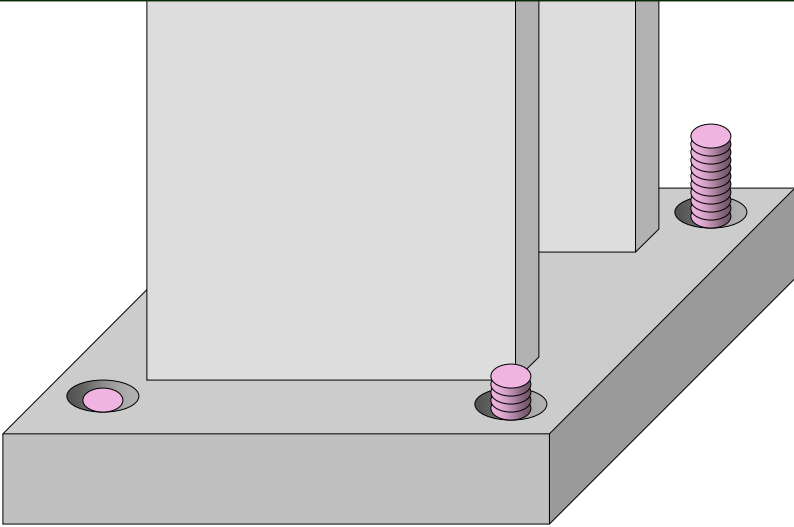
**15.12 Welding on Anchor Rods**

- Extending Anchor Rod
- Welding Anchor Rod to Base Plates



191

**PROBLEMS AND FIXES**



192

## PROBLEMS AND FIXES



### Extending Anchor Rods

- Secure the column
- Investigate mechanical options
- Investigate weldability



193

## AWS STANDARD WELDING TERMS & DEFINITIONS (A3.0:2020)




### **weldability.**

The relative ease with which a material may be welded to meet an applicable standard



194

## PROBLEMS AND FIXES




Welded Connections—  
A Primer for  
Engineers


### Weldability

- Based on composition
- Driven by carbon content
- Compounded by alloy content
- Related to “hardenability”
- “Hot cracking” concerns as well (S, P, others)

**Remember: weldability is not whether the material can be welded, but rather how easily can the material be welded.**

195


## PROBLEMS AND FIXES



Welded Connections—  
A Primer for  
Engineers

### Weldability Concerns With Anchor Rod Specifications

- High Carbon
- High Alloy
- Undefined Carbon, Alloy
- Heat Treatment (Q&T)

196

ASTM A1554-97a

Standard Specification for  
 Anchor Bolts, Steel, 36, 55, and  
 105-ksi Yield Strength

Designation: F 1554 - 97a

Standard Specification for  
 Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength<sup>1</sup>

This standard is issued under the fixed designation F 1554; the number immediately following the designation indicates the year of original approval or the year of last revision. The year of last revision is shown in parentheses immediately following the year of approval. It may be withdrawn at any time.

**1. Scope<sup>2</sup>**

1.1 This specification covers straight and hex, headed and unheaded, carbon, carbon-manganese, alloy, or high-strength low-alloy steel anchor bolts (also known as anchor rods). The anchor bolts are furnished in three strength grades, two thread classes, and in the sizes specified in Section 4.

1.2 The anchor bolts are intended for anchoring structural supports to concrete foundations. Such structural supports include building columns, column supports for highway signs, street lighting and traffic signals, steel bearing plates, and similar applications.

1.3 Supplementary requirements are included to provide for Grade 55 weldable steel, post-tensioning manufacturers and grade identification, and impact properties for Grades 55 and 105.

1.4 Zinc coating requirements are included in Section 7 for applications requiring corrosion protection.

1.5 The minimum chemical grade and alloy of steel and welder are included in 6.1 and 6.1.1 for each grade.

1.6 This specification does not cover the requirements for mechanical expansion anchors, powder-actuated nails, or nails, or anchor bolts fabricated from deformed bar.

1.7 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

**2. Referenced Documents**

2.1 ASTM Standards:<sup>3</sup>

A 193/A 193M Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service or Bolt

A 193 Test Methods and Definitions for Mechanical Testing of Steel Products

A 301 Specification for Carbon and Alloy Steel Nuts

A 615/A 615M Specification for Sampling Procedure for Impact Testing of Structural Steel

A 793 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

B 695 Specification for Coatings of Zinc-Mechanically Deposited on Iron and Steel

E 201 Practice for Commercial Packaging

F 416 Specification for Hot-Dipped Steel Washers

F 417 Test Methods for Determining the Mechanical Properties of Extruded and Internally Threaded Fasteners, Washers, Unions, Turned Indicators, and Brims

F 2129 Specification for Zinc Coating, Hot Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Nuts, Washers, Nails, and Special Threaded Fasteners

Z 22 Research Council on Structural Connections "Snap-shots"

Specification for Structural Steels Using ASTM A 325 or A 499 Bolts

Z 223 AISC Specification<sup>4</sup>

B 1.1 Labeled Screw Threads

B 1.2 Screw Thread Gaging Systems for Dimensional Accuracy

B 18.2.2 Inspection and Test Plans

B 21.10.20 Inspection and Quality Assurance for High Volume Machine Assembly Fasteners

**3. Terminology**

3.1 Definition of Terms Applicable to This Standard:

3.1.1 anchor bolt—steel rod or bar, one end of which is threaded to be cast in concrete, while the opposite end is threaded and projects from the concrete, for anchoring other members to the concrete. The end cast in concrete may be either straight or provided with an anchor nut as a hex disk, forged head, or a resistor or welder attachment to resist forces imposed on the anchor bolt, as required.

3.1.2 manufacturer—manufacturer of the anchor bolt; the party that performs the casting, heading, and threading operations.

3.1.3 producer—manufacturer of the steel ends or bars.

3.1.4 purchaser—purchaser of the finished anchor bolt, or the designated agent.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F15 on Irons and Steels and is the direct responsibility of Subcommittee F15.02 on Iron Bolts, Nuts, and Washers.

Current edition approved Dec. 1, 1997; Revised January 2008. Originally approved in 1954 and previous editions approved in 1957, 1970, and 1975.

<sup>2</sup> For additional ASTM standards, visit the ASTM website: [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [custserv@astm.org](mailto:custserv@astm.org). For a complete list of ASTM standards, visit the standard's Technical Summary page on the ASTM website.

<sup>3</sup> Available from American Institute of Steel Construction, 65 Leonard Street, Suite 550, Westchester, NY 10804.

<sup>4</sup> Available from American Institute of Steel Construction, 65 Leonard Street, Suite 550, Westchester, NY 10804.

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ASTM A1554-97a

Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

Three Grades

**4. Classification**

4.1 The anchor bolts are furnished in three grades denoting minimum yield strength and two classes denoting thread class as follows:


Grade	Tensile Strength, ksi (MPa)	Description Yield Strength, min, ksi (MPa)	Size Range, in. (mm)
36 <sup>A</sup>	58–80 (400–558)	36 (248)	¼–4 (6.4–102)
55	75–95 (517–655)	55 (380)	¼–4 (6.4–102)
105	125–150 (862–1034)	105 (724)	¼–3 (6.4–76)
Class			
1A		anchor bolts with Class 1A threads	
2A		anchor bolts with Class 2A threads	

<sup>A</sup> When Grade 36 is specified, a weldable Grade 55 may be furnished at the supplier's option.

198

**ASTM A1554-97a**  
 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

4.2 Weldable steel for Grade 55 is provided for in Supplementary Requirement SI.



199

**ASTM A1554-97a**  
 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

**Substitution option: weldable  
 Grade 55 for Grade 36**

**4. Classification**


4.1 The anchor bolts are furnished in three grades denoting minimum yield strength and two classes denoting thread class as follows:

Grade	Tensile Strength, ksi (MPa)	Description Yield Strength, min, ksi (MPa)	Size Range, in. (mm)
36 <sup>A</sup>	58–80 (400–558)	36 (248)	¼ –4 (6.4–102)
55	75–95 (517–655)	55 (380)	¼ –4 (6.4–102)
105	125–150 (862–1034)	105 (724)	¼ –3 (6.4–76)

Class


1A anchor bolts with Class 1A threads  
 2A anchor bolts with Class 2A threads

<sup>A</sup> When Grade 36 is specified, a weldable Grade 55 may be furnished at the supplier's option.




200

<b>ASTM A1554-97a</b>	
Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength	
Permitted Options	
Ordered	Delivered
Grade 36	Grade 36
	Grade 55 S1
Grade 55	Grade 55
	Grade 55 S1
Grade 55 S1	Grade 55 S1
Grade 105	Grade 105



<b>ASTM A1554-97a</b>	
Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength	
Permitted Options	
Ordered	Delivered
Grade 36	Grade 36
	Grade 55 S1
Grade 55	Grade 55
	Grade 55 S1
Grade 55 S1	Grade 55 S1
Grade 105	Grade 105

Four Types to be Considered




**ASTM A1554-97a**  
 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

**TABLE 1 Chemical Requirements for Grade 36**

Element	Diameter, in. (mm)		
	To ¾ (20), incl	Over ¾ to 1½ (20 to 40), incl	Over 1½ to 4 (40 to 100), incl
Carbon, max, %			
Heat	0.26	0.27	0.28
Product	0.29	0.30	0.31
Manganese, %			
Heat	<sup>A</sup> 0.60–0.90	0.60–0.90	0.60–0.90
Product		0.54–0.98	0.54–0.98
Phosphorus, max, %			
Heat		0.04	0.04
Product		0.05	0.05
Sulfur, max, %			
Heat	0.05	0.05	0.05
Product	0.06	0.06	0.06
Copper, min, % (when specified)			
Heat	0.20	0.20	0.20
Product	0.18	0.18	0.18

<sup>A</sup> Optional with the manufacturer but shall be compatible with weldable steel.

Similar to A36




**ASTM A1554-97a**  
 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

**TABLE 2 Chemical Requirements for Grades 55 and 105**

Element	Composition, %	
	Heat Analysis	Product Analysis
Phosphorous, max	0.040	0.048
Sulfur, max	0.050	0.058
Copper, min (when Cu is specified)	0.20	0.18

No controls on carbon  
or alloy content




**ASTM A1554-97a**  
 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

**Grade 55 S1**

**S1. Grade 55 Bars and Anchor Bolts**

S1.1 The material described in this section is intended for welding. This supplemental section, by chemical composition restrictions and by a carbon equivalent formula, provides assurance of weldability.

S1.2 Welding technique is of fundamental importance when bolts produced to this supplementary section are welded. It is assumed that suitable welding procedures for the steel being welded and the intended service will be selected.



**ASTM A1554-97a**  
 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength

**Grade 55 S1**


S1.5 *Chemical Composition:*

S1.5.1 Steel shall conform to the following limitations:

	Heat Analysis	Product Analysis
Carbon, max, %	0.30	0.33
Manganese, max, %	1.35	1.41
Phosphorus, max, %	0.040	0.048
Sulfur, max, %	0.050	0.058
Silicon, max, %	0.50	0.55

**Cold Cracking Controls** (indicated by red arrows pointing to Carbon, Manganese, Phosphorus, and Sulfur)

**Hot Cracking Controls** (indicated by a blue arrow pointing to Silicon)



**ASTM A1554-97a**  
Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength


**Grade 55 S1**

S1.5.2 *Carbon Equivalent*—In addition to the requirements specified in S1.5.1, the analysis shall be such as to provide a carbon equivalent (CE) meeting the following requirements:

S1.5.2.1 For alloy or low-alloy steel, the carbon equivalent shall not exceed **0.45 %** when calculated as follows:

$$CE = \% C + \frac{\% Mn}{6} + \frac{\% Cu}{40} + \frac{\% Ni}{20} + \frac{\% Cr}{10} + \frac{\% Mo}{50} + \frac{\% V}{10}$$

S1.5.2.2 For carbon steel, the carbon equivalent shall not exceed **0.40 %** when calculated as follows:


$$CE = \% C + \frac{\% Mn}{4}$$


**Weldability of Anchor Rods**

**Grade 36**

- Chemistry is similar to that of ASTM A36
- Deviation on Mn permitted only for smaller rods
- If Grade 55 is substituted, only weldable (S1) material may be used

**Weldability should be good.**



## Weldability of Anchor Rods

### Grade 55

- The only chemistry control is on S, P (and Cu, when Cu is specified)
- No weldability promises

**Weldability should be investigated on a case-by-case basis.**



209

## Weldability of Anchor Rods

### Grade 55 S1

- Chemistry is similar to that of ASTM A36
- Carbon equivalency limits
- “The material described in this section is intended for welding.”
- “This supplemental section...provides assurance of weldability.”

**Weldability should be good.**



210

## Weldability of Anchor Rods

### Grade 105

- The only chemistry control is on S, P (and Cu, when Cu is specified)
- No weldability promises
- High strength (105 ksi yield)
- May be quenched and tempered

**Weldability is likely to be poor.**

**Caveat:** poor weldability does not mean unweldable.



211

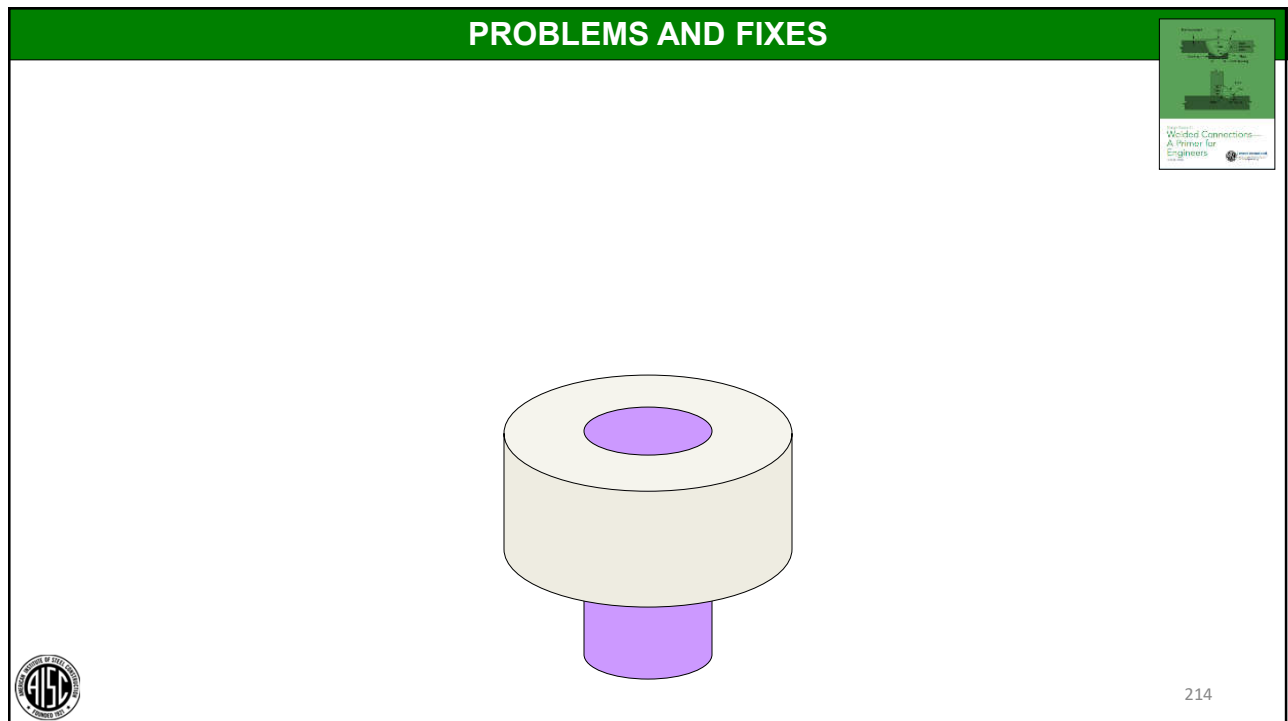
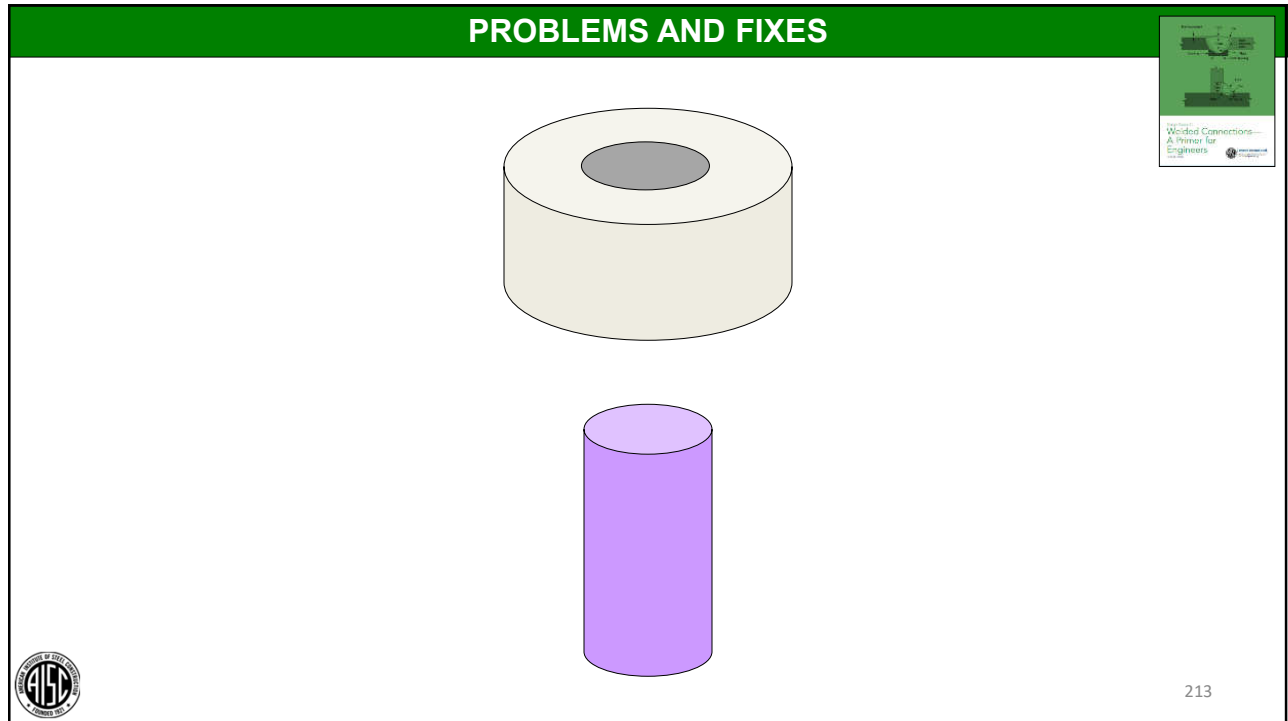
## PROBLEMS AND FIXES

### Extending Anchor Rods

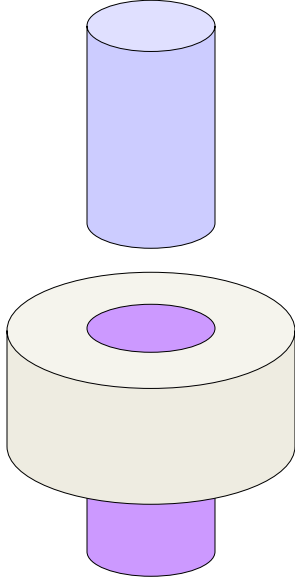
- Secure the column
- Investigate mechanical options
- Investigate weldability
- Use an appropriate detail





212



### PROBLEMS AND FIXES



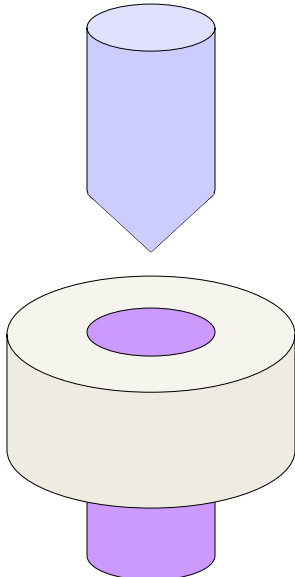
The diagram shows a light-colored cylindrical component with a central hole. A purple cylindrical piece is positioned below the hole, protruding through it. Above the main component, a separate purple cylinder is shown, representing a part to be attached or a problem to be fixed.





215

### PROBLEMS AND FIXES

Note:  
chisel-point,  
not pencil-point

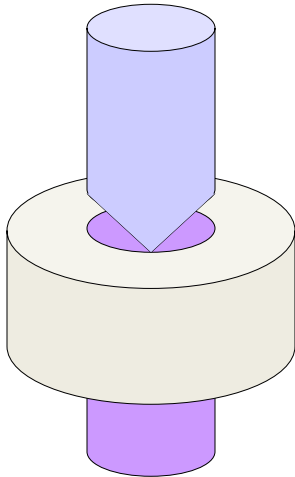


The diagram is similar to the one above, but the purple cylinder above the hole has a pointed, chisel-like tip instead of a flat top. This illustrates a specific problem or fix related to the fit of the component.




216


### PROBLEMS AND FIXES



A 3D perspective diagram of a cylindrical component. A light blue cylinder is positioned on top of a larger, light tan cylindrical base. The top surface of the base has a purple-shaded area where it meets the blue cylinder, indicating a problem with the weld or fit.

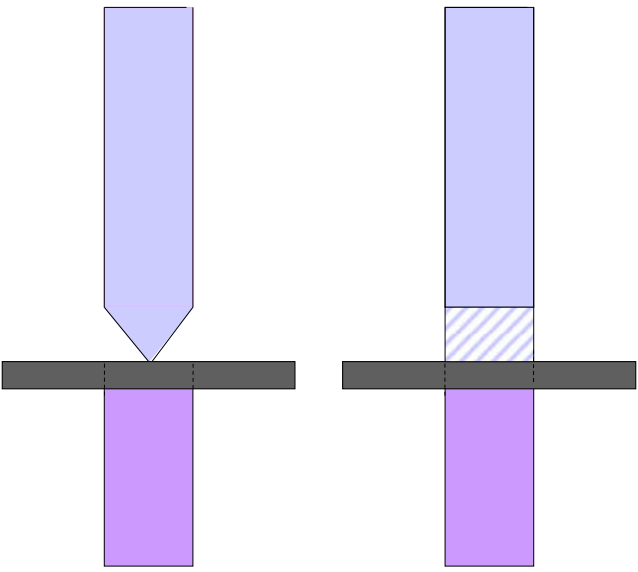


Welded Connections—  
A Primer for  
Engineers




217


### PROBLEMS AND FIXES



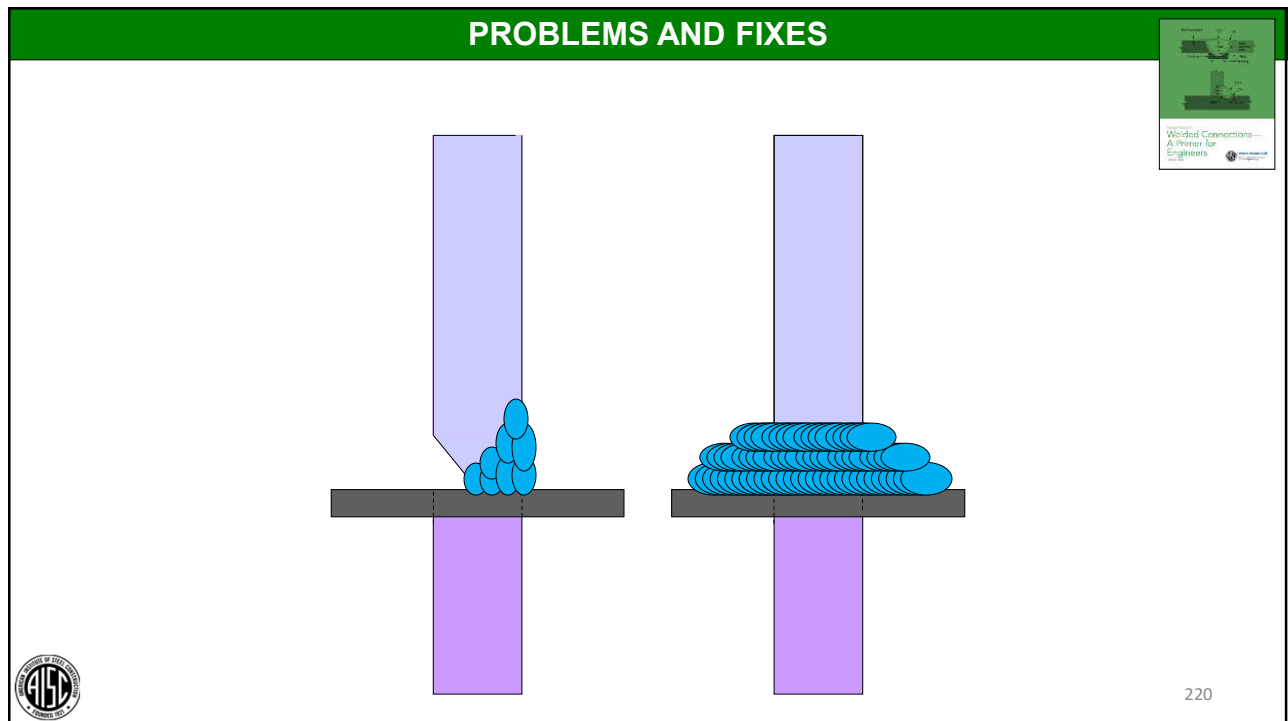
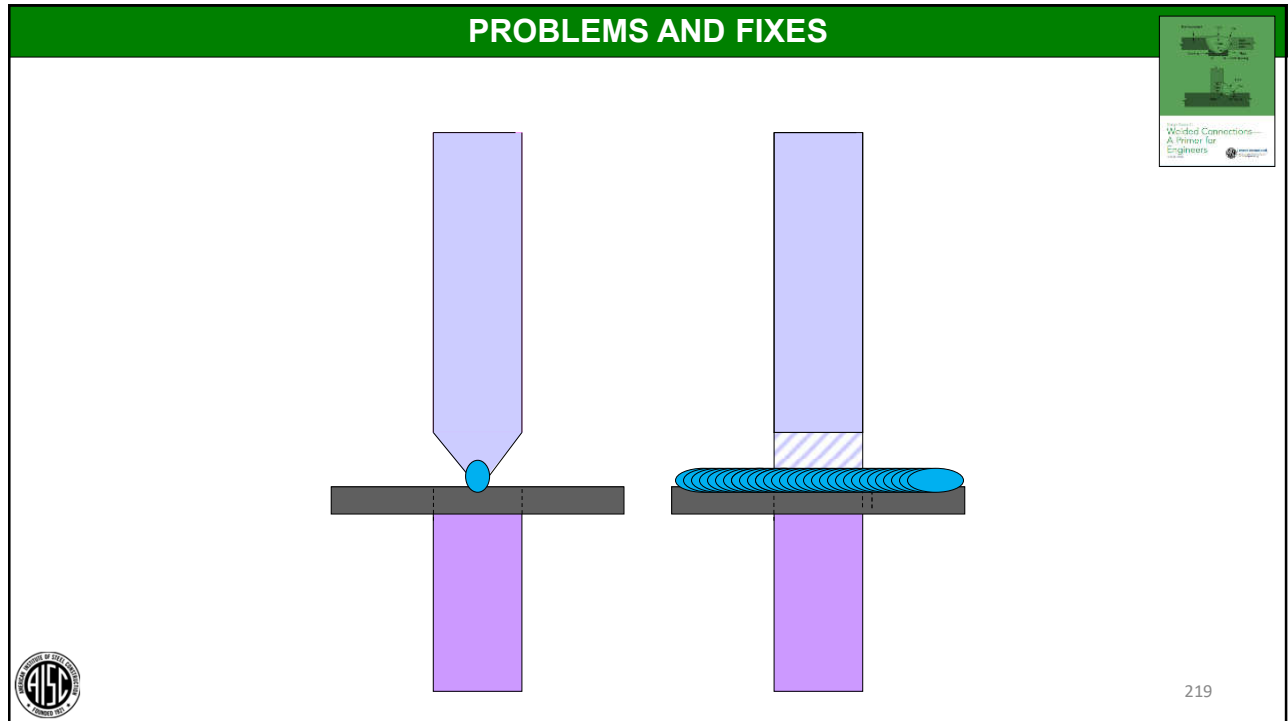
Two side-by-side diagrams of a T-joint. The left diagram shows a light blue vertical member on top of a purple vertical member, with a horizontal grey member connecting them. A purple-shaded area at the top of the purple member indicates a problem. The right diagram shows the same joint, but with a hatched area at the top of the purple member, indicating a fix or repair.

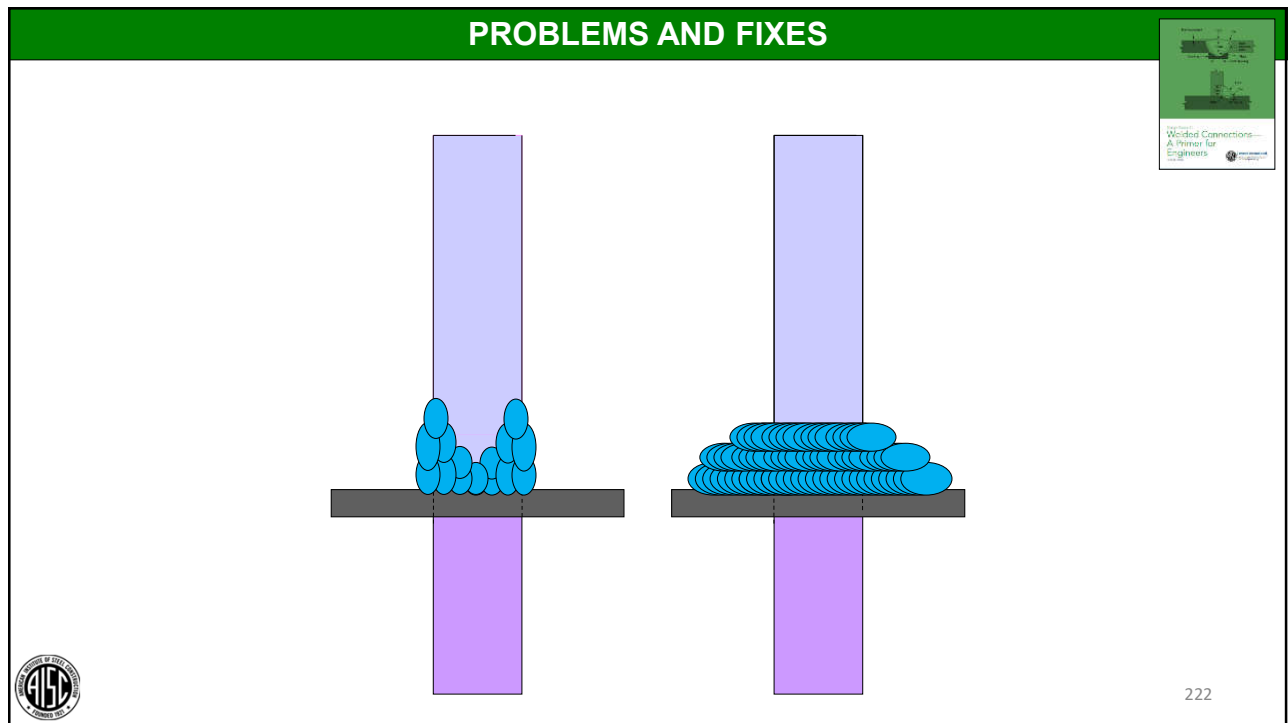
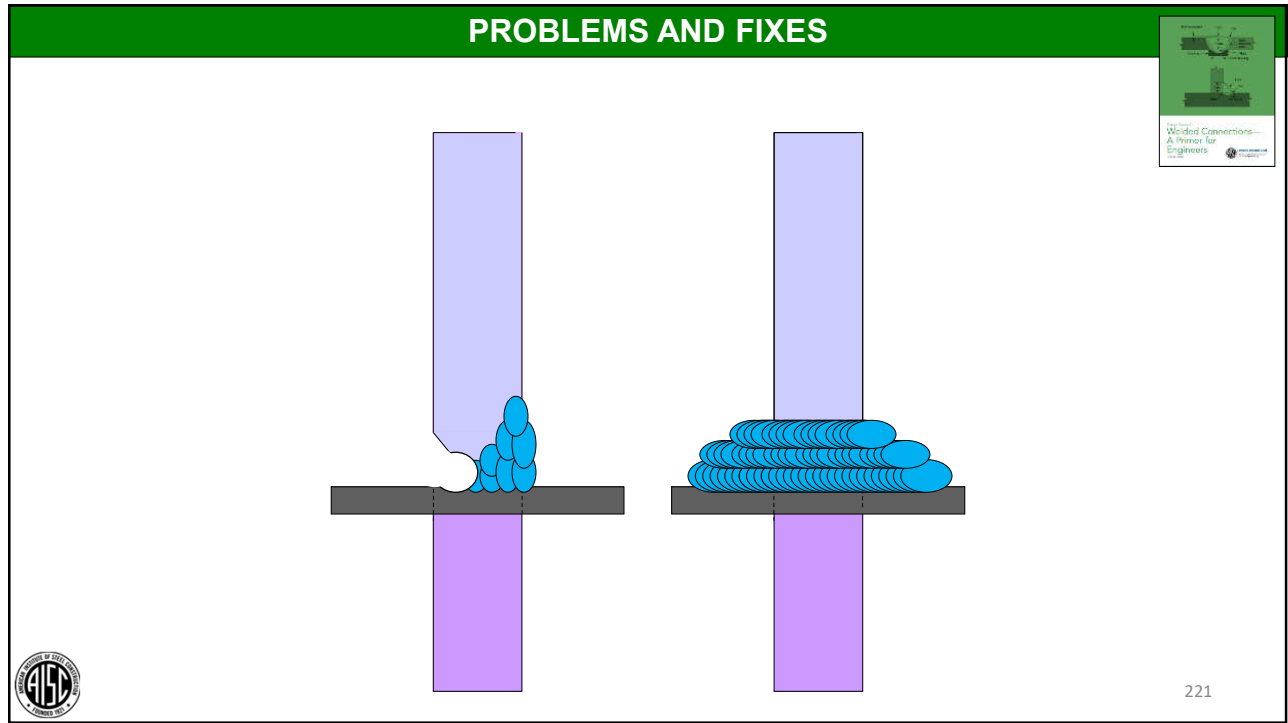


Welded Connections—  
A Primer for  
Engineers

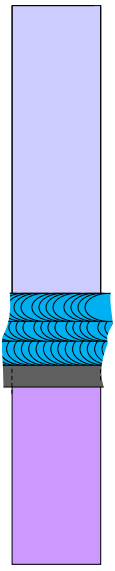
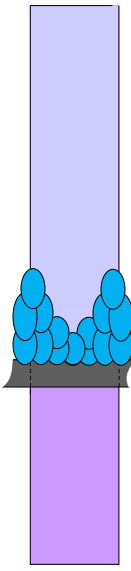



218






### PROBLEMS AND FIXES

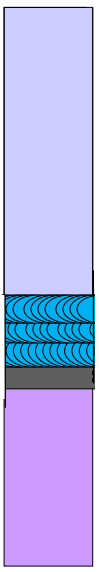
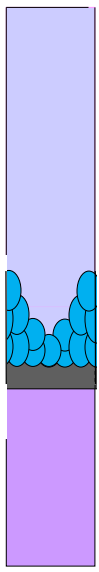





Welded Connections—  
A Primer for  
Engineers


223

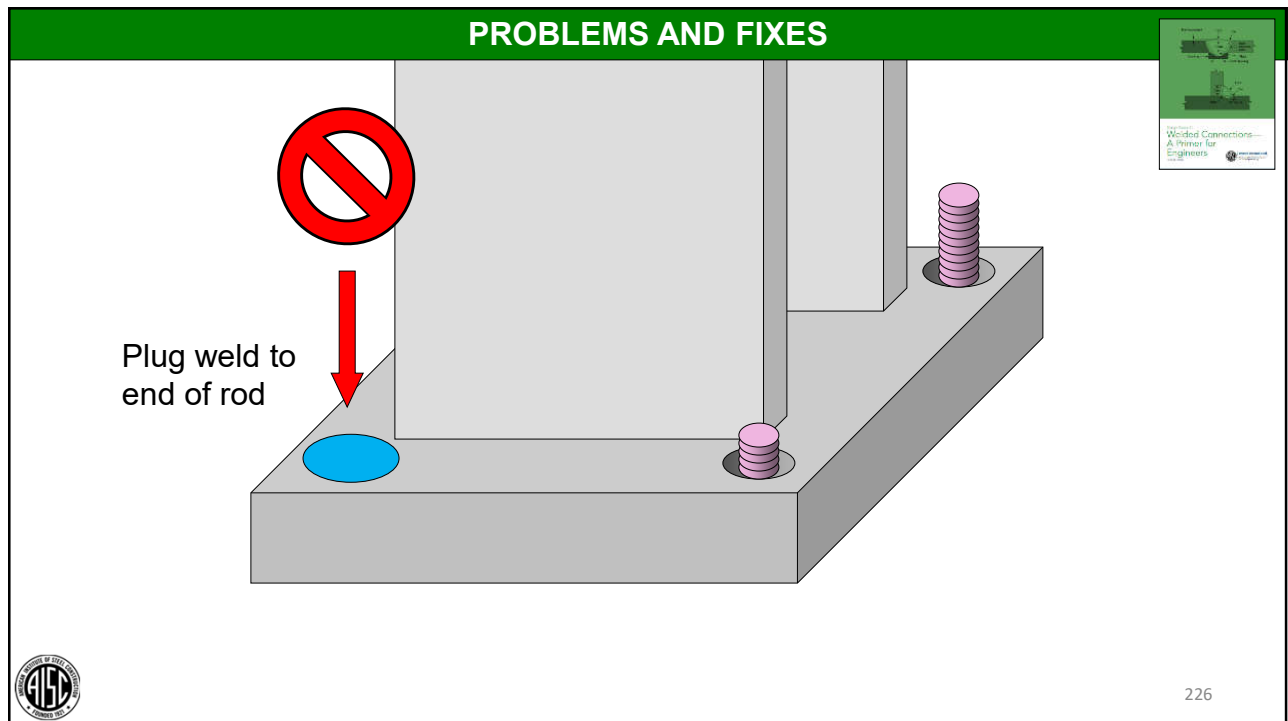
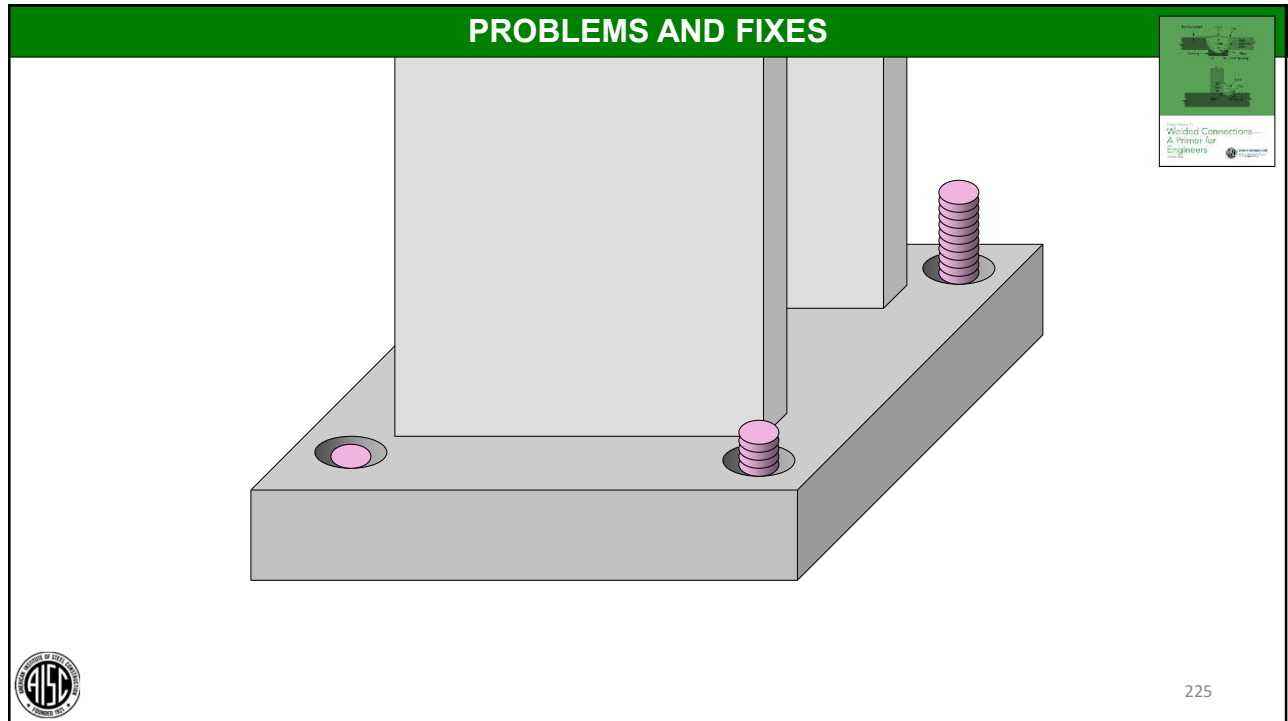
### PROBLEMS AND FIXES

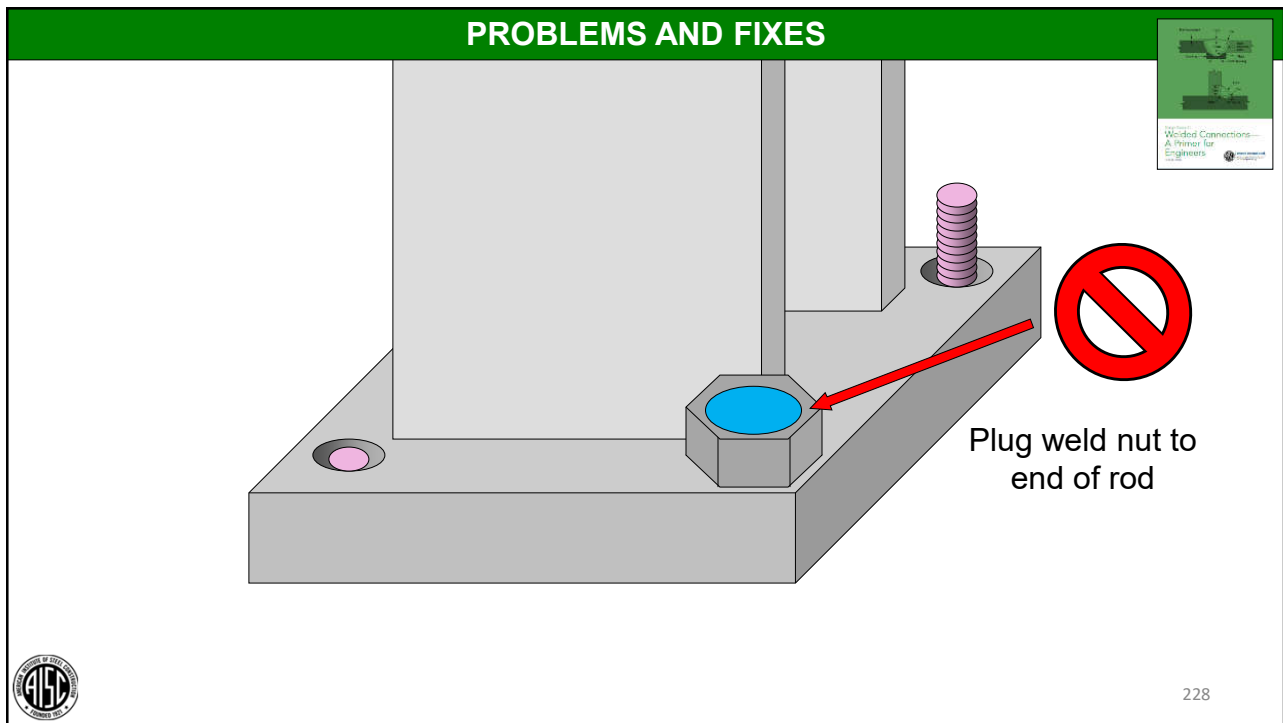
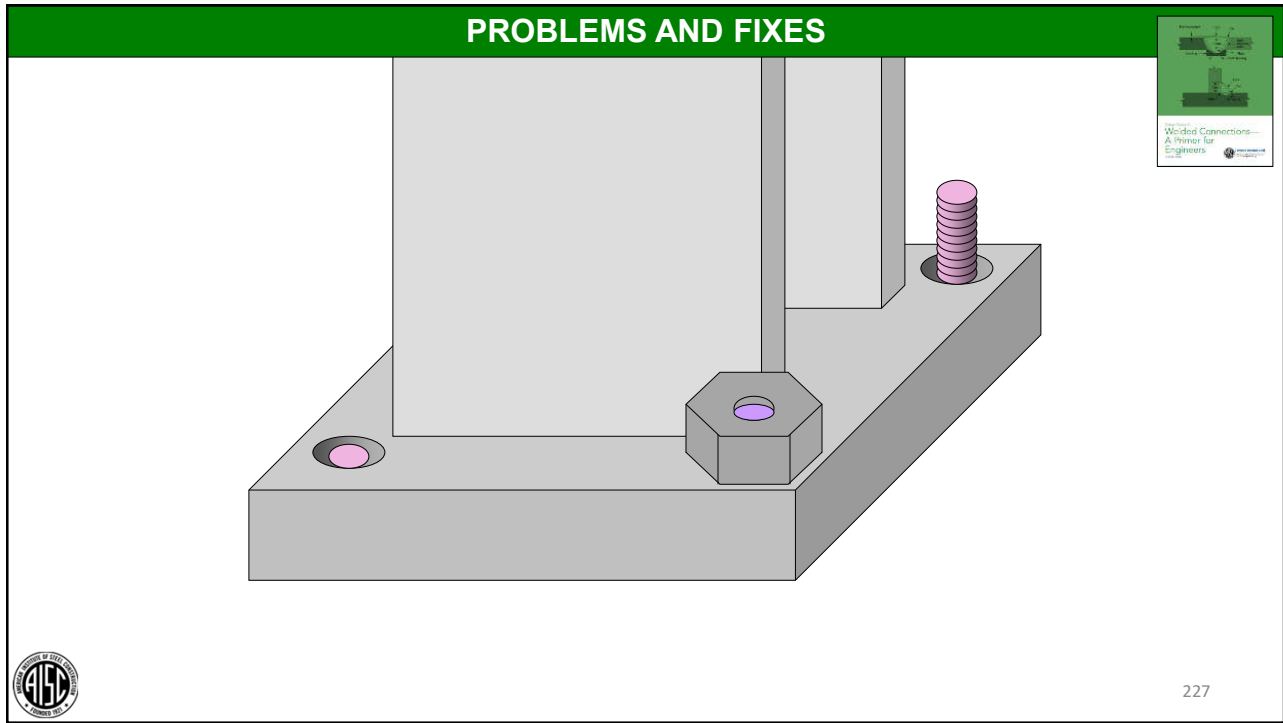




Welded Connections—  
A Primer for  
Engineers

224







**PROBLEMS AND FIXES**



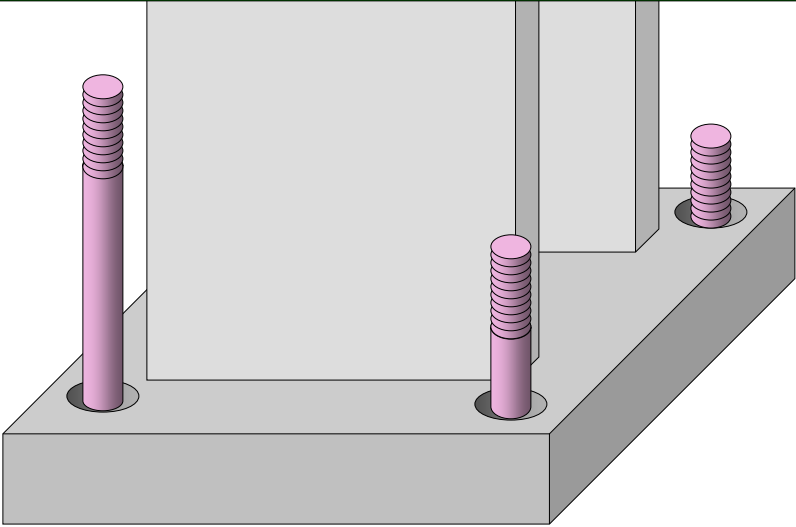
**15.12 Welding on Anchor Rods**

- Extending Anchor Rod
- Welding Anchor Rod to Base Plates




229

**PROBLEMS AND FIXES**




230

## PROBLEMS AND FIXES




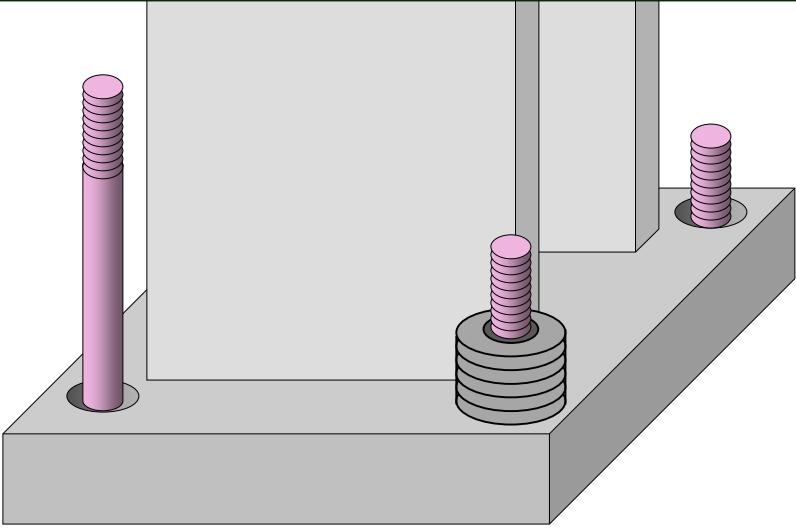
### Welding Anchor Rod to Base Plates


- Secure the column
- Is there sufficient anchorage?
- Investigate mechanical options

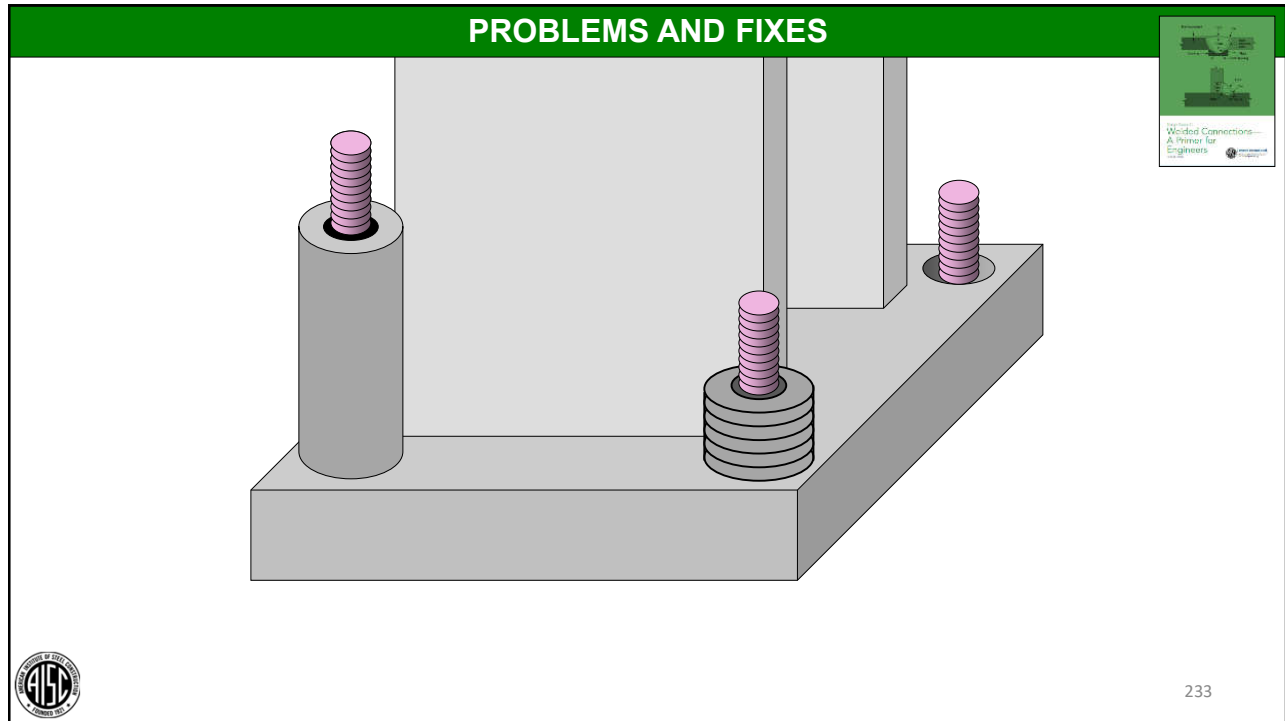
231

## PROBLEMS AND FIXES





232

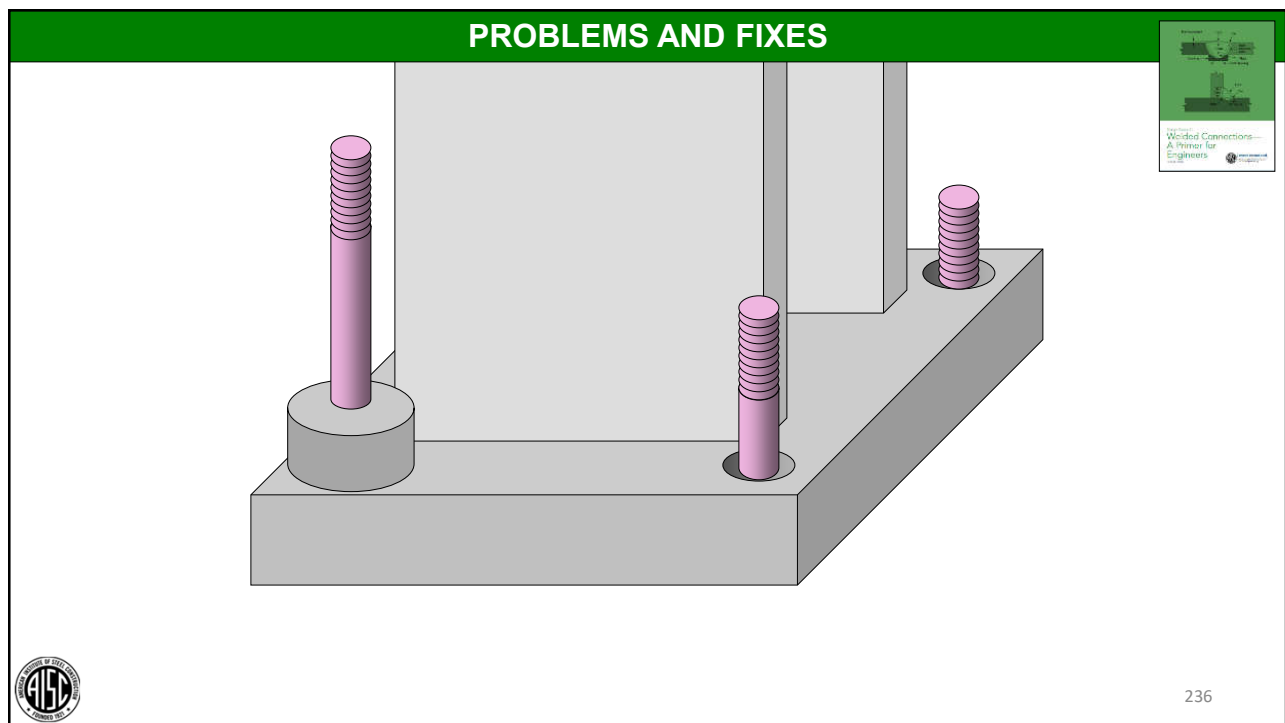
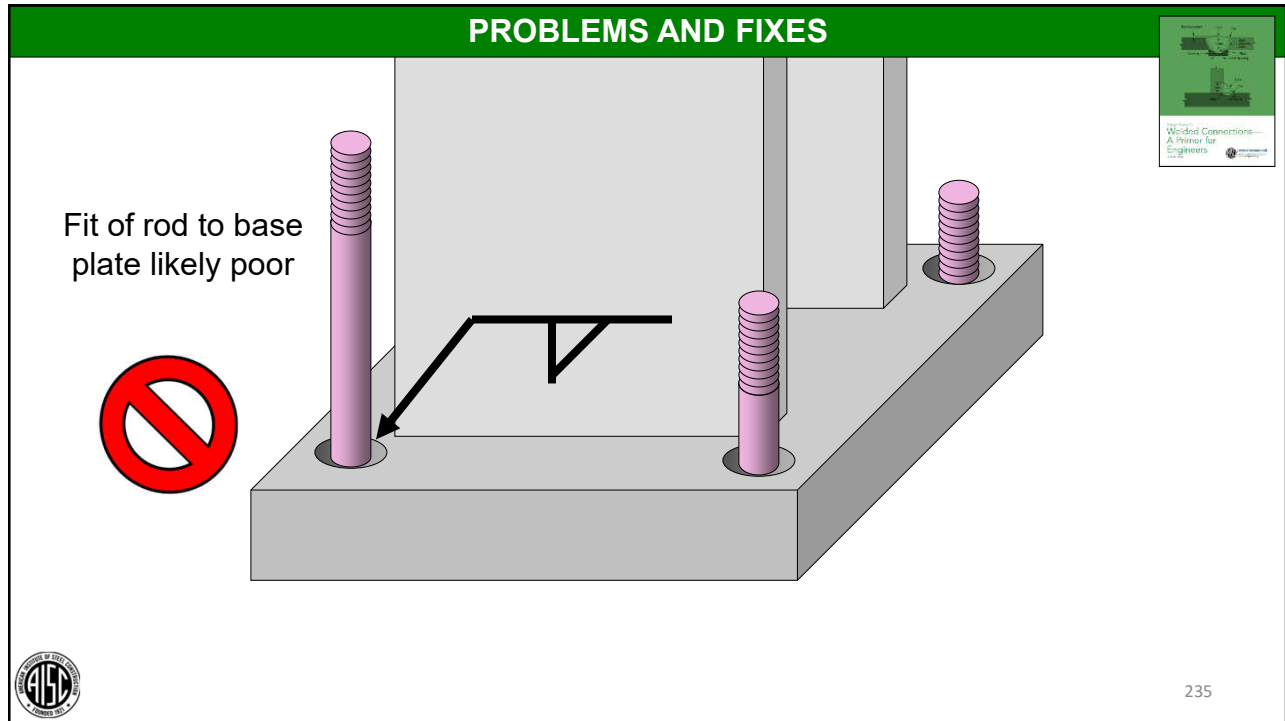


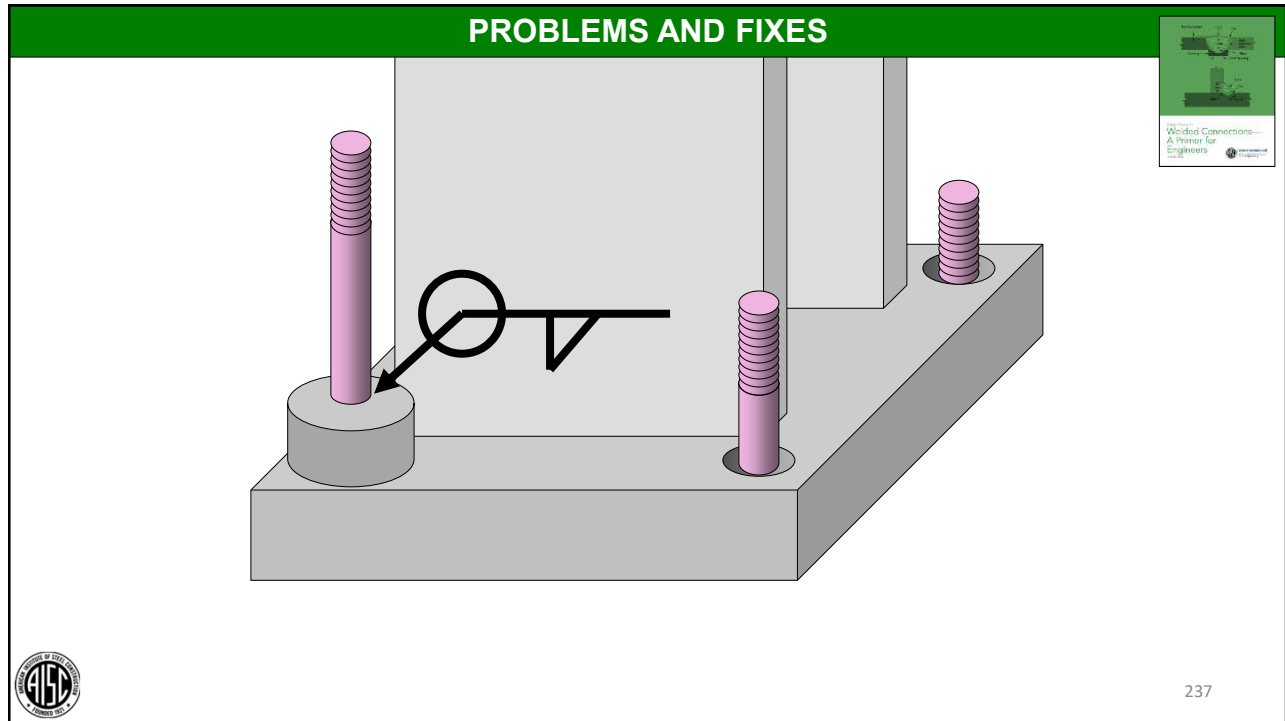
**PROBLEMS AND FIXES**

**Welding Anchor Rod to Base Plates**

- Secure the column
- Is there sufficient anchorage?
- Investigate mechanical options
- Investigate weldability
- Use an appropriate detail

234





- 
- PROBLEMS AND FIXES**
- 15.9 Heat Shrinking of Q&T Steel
  - ➔ 15.10 Unspecified Welds
  - 15.11 Welds Made Without Inspection
  - 15.12 Welding on Anchor Rods
  - 15.13 Welding Anchor Rod to Base Plates
  - 15.14 Removing And Reinstalling Column Base Plates
  - 15.15 Repairing Lamellar Tears
- Welded Connections—  
A Primer for  
Engineers
- 238

## PROBLEMS AND FIXES



### Unspecified Welds

Unspecified welds are welds made on a structure that are not identified on contract, shop, or erection drawings.

Tack welds and construction aid welds are separately discussed in AWS D1.1, clause 7.17, with specific provisions for dealing with each type of weld; these are not categorized as unspecified welds.



239

## AWS D1.1:2020 Structural Welding Code--Steel



### 8.5 Inspection of Work and Records

#### 8.5.1 Size, Length, and Location of Welds.

The Inspector shall ensure that the size, length, and location of all welds conform to the requirements of this code and to the detail drawings and that **no unspecified welds have been added** **without the approval of the Engineer.**





240

**PROBLEMS AND FIXES**

**Unspecified Welds**

The question to be answered: **Why?**

**“When it rains, it pours”**



241



**PROBLEMS AND FIXES**

**Unspecified Welds**

“Additional caution should be given to unspecified welds when the structure is subjected to **cyclic** or **seismic** loading.”


“In most cases, problematic unspecified welds can be removed and the localized area repaired by grinding.”

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242

## PROBLEMS AND FIXES




Welded Connections—  
A Primer for  
Engineers

- 15.9 Heat Shrinking of Q&T Steel
- 15.10 Unspecified Welds
-  15.11 Welds Made Without Inspection
- 15.12 Welding on Anchor Rods
- 15.13 Welding Anchor Rod to Base Plates
- 15.14 Removing And Reinstalling Column Base Plates
- 15.15 Repairing Lamellar Tears

243


## PROBLEMS AND FIXES




Welded Connections—  
A Primer for  
Engineers


**Question:**  
The weld was done without the requisite inspection. Do I have it removed and replaced with the inspector present?

**A related theoretical question:**  
Is it possible for a welder to make a good weld if an inspector is not present?



244



**AISC 360:16 Specification for Structural Steel Buildings**



**CHAPTER N**


**QUALITY CONTROL AND QUALITY ASSURANCE**

This chapter addresses **minimum requirements for quality control, quality assurance and nondestructive testing** for structural steel systems and steel elements of composite members for buildings and other structures.



245



**AISC 360:16 Specification for Structural Steel Buildings**



**N5. MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS**


**4. Inspection of Welding**

**Observation of welding operations and visual inspection of in-process and completed welds** shall be the primary method to confirm that the materials, procedures and workmanship are in conformance with the construction documents.



246


**AISC 360:16 Specification for Structural Steel Buildings**



**N5. MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS**


**4. Inspection of Welding (cont'd)**

As a minimum, welding inspection tasks shall be in accordance with Tables N5.4-1, N5.4-2 and N5.4-3. In these tables, the inspection tasks are as follows:



247

**AISC 360:16 Specification for Structural Steel Buildings**




**N5. MINIMUM REQUIREMENTS FOR INSPECTION OF STRUCTURAL STEEL BUILDINGS**

**4. Inspection of Welding (cont'd)**

(a) Observe (O): The inspector shall observe these items on a random basis. Operations need not be delayed pending these inspections.

(b) Perform (P): These tasks should be performed for each welded joint or member.

• •



248

AISC 360:16 Specification for Structural Steel Buildings		
<b>TABLE N5.4-1</b> <b>Inspection Tasks <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">Prior</span> to Welding</b>		
Inspection Tasks Prior to Welding	QC	QA
Welder qualification records and continuity records	P	O
WPS available	P	P
Manufacturer certifications for welding consumables available	P	P
Material identification (type/grade)	O	O
Welder identification system <sup>[a]</sup>	O	O

249

AISC 360:16 Specification for Structural Steel Buildings		
<b>TABLE N5.4-2</b> <b>Inspection Tasks <span style="border: 1px solid red; border-radius: 50%; padding: 2px;">During</span> Welding</b>		
Inspection Tasks During Welding	QC	QA
Control and handling of welding consumables <ul style="list-style-type: none"> <li>• Packaging</li> <li>• Exposure control</li> </ul>	O	O
No welding over cracked tack welds	O	O
Environmental conditions <ul style="list-style-type: none"> <li>• Wind speed within limits</li> <li>• Precipitation and temperature</li> </ul>	O	O

250

AISC 360:16 Specification for Structural Steel Buildings		
<b>TABLE N5.4-3</b> <b>Inspection Tasks After Welding</b>		
Inspection Tasks After Welding	QC	QA
Welds cleaned	O	O
Size, length and location of welds	P	P
Welds meet visual acceptance criteria <ul style="list-style-type: none"> <li>• Crack prohibition</li> <li>• Weld/base-metal fusion</li> <li>• Crater cross section</li> <li>• Weld profiles</li> <li>• Weld size</li> <li>• Undercut</li> </ul>	P	P

251

AISC 360:16 Specification for Structural Steel Buildings		
<b>TABLE N5.4-3</b> <b>Inspection Tasks After Welding</b>		
Inspection Tasks After Welding	QC	QA
Welds cleaned	O	O
Size, length and location of welds	P	P
Welds meet visual acceptance criteria <ul style="list-style-type: none"> <li>• Crack prohibition</li> <li>• Weld/base-metal fusion</li> <li>• Crater cross section</li> <li>• Weld profiles</li> <li>• Weld size</li> <li>• Undercut</li> <li>• Porosity</li> </ul>	P	P
Arc strikes	P	P
k-area <sup>(a)</sup>	P	P
Weld access holes in rolled heavy shapes and built-up heavy shapes <sup>(b)</sup>	P	P
Backing removed and weld tabs removed (if required)	P	P
Repair activities	P	P
Document acceptance or rejection of welded joint or member	P	P
No prohibited welds have been added without the approval of the EOR	O	O

All of these inspections can still be performed

252

**AISC 360:16 Specification for Structural Steel Buildings**

Specification for Structural Steel Buildings

Inspection Tasks Prior to Welding	QC	QA
Welder qualification records and continuity records ✓	P	O
WPS available ✓	P	P
Manufacturer certifications for welding consumables available ✓	P	P
Material identification (type/grade) ✓	O	O
Welder identification system <sup>(1)</sup> ✓	O	O
Fit-up of groove welds (including joint geometry) <ul style="list-style-type: none"> <li>• Joint preparations</li> <li>• Dimensions (alignment, root opening, root face, bevel)</li> <li>• Cleanliness (condition of steel surfaces)</li> <li>• Tacking (tack weld quality and location) ✓</li> <li>• Backing type and fit (if applicable) ✓</li> </ul>	O	O
Fit-up of CJP groove welds of HSS T-, Y- and K-joints without backing (including joint geometry) <ul style="list-style-type: none"> <li>• Joint preparations</li> <li>• Dimensions (alignment, root opening, root face, bevel)</li> <li>• Cleanliness (condition of steel surfaces)</li> <li>• Tacking (tack weld quality and location) ✓</li> </ul>	P	O
Configuration and finish of access holes ✓	O	O
Fit-up of fillet welds <ul style="list-style-type: none"> <li>• Dimensions (alignment, gaps at root)</li> <li>• Cleanliness (condition of steel surfaces)</li> <li>• Tacking (tack weld quality and location)</li> </ul>	O	O
Check welding equipment ✓	O	-

Some of these inspections can still be performed

(1) The fabricator or erector, as applicable, shall maintain a system by which a welder who has welded a joint or member can be identified. Stamps, if used, shall be the low-stress type.

253

**AISC 360:16 Specification for Structural Steel Buildings**

Specification for Structural Steel Buildings

Inspection Tasks During Welding	QC	QA
Control and handling of welding consumables <ul style="list-style-type: none"> <li>• Packaging ✓</li> <li>• Exposure control</li> </ul>	O	O
No welding over cracked tack welds	O	O
Environmental conditions <ul style="list-style-type: none"> <li>• Wind speed within limits</li> <li>• Precipitation and temperature</li> </ul>	O	O
WPS followed <ul style="list-style-type: none"> <li>• Settings on welding equipment</li> <li>• Travel speed</li> <li>• Selected welding materials ✓</li> <li>• Shielding gas type/flow rate</li> <li>• Preheat applied</li> <li>• Interpass temperature maintained (min./max.)</li> <li>• Proper position (F, V, H, OH)</li> </ul>	O	O
Welding techniques <ul style="list-style-type: none"> <li>• Interpass and final cleaning</li> <li>• Each pass within profile limitations</li> <li>• Each pass meets quality requirements</li> </ul>	O	O
Placement and installation of steel headed stud anchors ✓	P	P

Some of these inspections can still be performed

254

**AISC 360:16 Specification for Structural Steel Buildings**

**TABLE N5.4-1  
 Inspection Tasks Prior to Welding**

Inspection Tasks Prior to Welding	QC	QA
Welder qualification records and continuity records	P	O
WPS available	P	P
Manufacturer certifications for welding consumables available	P	P
Material identification (type/grade)	O	O
Welder identification system <sup>(1)</sup>	O	O
Fit-up of groove welds (including joint geometry) <ul style="list-style-type: none"> <li>• Joint preparations</li> <li>• Dimensions (alignment, root opening, root face, bevel)</li> <li>• Cleanliness (condition of steel surfaces)</li> <li>• Tacking (tack weld quality and location)</li> <li>• Backing type and fit (if applicable)</li> </ul>	O	O
Fit-up of CJP groove welds of HSS T-, Y- and K-joints without backing (including joint geometry) <ul style="list-style-type: none"> <li>• Joint preparations</li> <li>• Dimensions (alignment, root opening, root face, bevel)</li> <li>• Cleanliness (condition of steel surfaces)</li> <li>• Tacking (tack weld quality and location)</li> </ul>	P	O
Configuration and finish of access holes	O	O
Fit-up of fillet welds <ul style="list-style-type: none"> <li>• Dimensions (alignment, gaps at root)</li> <li>• Cleanliness (condition of steel surfaces)</li> <li>• Tacking (tack weld quality and location)</li> </ul>	O	O
Check welding equipment	O	-

<sup>(1)</sup> The fabricator or erector, as applicable, shall maintain a system by which a welder who has welded a joint or member can be identified. Stamps, if used, shall be the low-stress type.

255

Only two "p" tasks, and those can be done after welding is completed.

**AISC 360:16 Specification for Structural Steel Buildings**

**TABLE N5.4-2  
 Inspection Tasks During Welding**

Inspection Tasks During Welding	QC	QA
Control and handling of welding consumables <ul style="list-style-type: none"> <li>• Packaging</li> <li>• Exposure control</li> </ul>	O	O
No welding over cracked tack welds	O	O
Environmental conditions <ul style="list-style-type: none"> <li>• Wind speed within limits</li> <li>• Precipitation and temperature</li> </ul>	O	O
WPS followed <ul style="list-style-type: none"> <li>• Settings on welding equipment</li> <li>• Travel speed</li> <li>• Selected welding materials</li> <li>• Shielding gas type/flow rate</li> <li>• Preheat applied</li> <li>• Interpass temperature maintained (min./max.)</li> <li>• Proper position (F, V, H, OH)</li> </ul>	O	O
Welding techniques <ul style="list-style-type: none"> <li>• Interpass and final cleaning</li> <li>• Each pass within profile limitations</li> <li>• Each pass meets quality requirements</li> </ul>	O	O
Placement and installation of steel headed stud anchors	P	P

256

No "p" tasks (except for studs)

## PROBLEMS AND FIXES



### Question:

The weld was done without the requisite inspection. Do I have it removed and replaced with the inspector present?

### Questions that should be asked?

- Do the welds meet the visual acceptance criteria?
- Has anything changed?
- Does it pass the smell test?




257



258

**PROBLEMS AND FIXES**




**Question:**

The weld was done without the requisite inspection. Do I have it removed and replaced with the inspector present?

**Possible answers:**


No, providing a careful review of the situation reveals no significant non-conformances.

Yes, if the review reveals defective welds.



259

**PROBLEMS AND FIXES**



260

# Thank you!

**AISC** | Questions



## Individual Session Registrants

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### PDH Certificates

- All WFH individuals associated with a group registration will be issued a certificate.
- All individuals attending at your connection: you will receive an email on how to report their attendance from: [registration@aisc.org](mailto: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!



## 8-Session Registrants

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### PDH Certificates

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



## 8-Session Registrants

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### Access to the quiz

Information for accessing the quiz will be emailed to you by Wednesday. It will contain a link to access the quiz. EMAIL COMES FROM [NIGHTSCHOOL@AISC.ORG](mailto:NIGHTSCHOOL@AISC.ORG).

### Quiz and attendance records

Posted Friday mornings. [www.aisc.org/nightschool](http://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*



## 8-Session Registrants

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### Access to the recording

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

### PDHs via recording

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



## 8-Session Registrants

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### Night School Resources

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



## 8-Session Registrants

### Night School Resources

Go to [www.aisc.org](http://www.aisc.org) and sign in.

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## 8-Session Registrants

### Night School Resources

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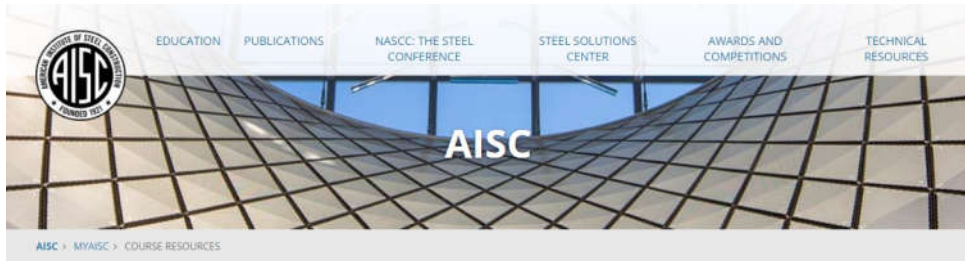
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View online resources for Night School and Live Webinar package registrat

[VIEW RESOURCES](#)

# 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



# 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	<a href="#">Handouts</a>	<a href="#">View</a> Passcode: NS13DSN	Pass Score: 80	Pending
NS13 - Economic Considerations	2/6/2017 7:00:00 PM	<a href="#">Handouts</a>	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	<a href="#">Handouts</a>	Available 02/15/2017 5pm EST	Available 02/15/2017 5pm EST	Pending
NS13 - Preliminary Design Procedures	2/27/2017 7:00:00 PM	<a href="#">Handouts</a>	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	<a href="#">Handouts</a>	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	<a href="#">Handouts</a>	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	<a href="#">Handouts</a>	Available 03/29/2017 5pm EST	Available 03/29/2017 5pm EST	Pending
NS13 - Building Envelope and Bracing Design	4/3/2017 7:00:00 PM	<a href="#">Handouts</a>	Available 04/05/2017 5pm EST	Available 04/05/2017 5pm EST	Pending

## 8-Session Registrants

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### Night School Resources

- Weekly “quiz and recording” email.
- Weekly updates of the master quiz and attendance record, found at [www.aisc.org/nightschool27](http://www.aisc.org/nightschool27). Scroll down to Quiz and Attendance records.
  - Updated on Friday mornings.



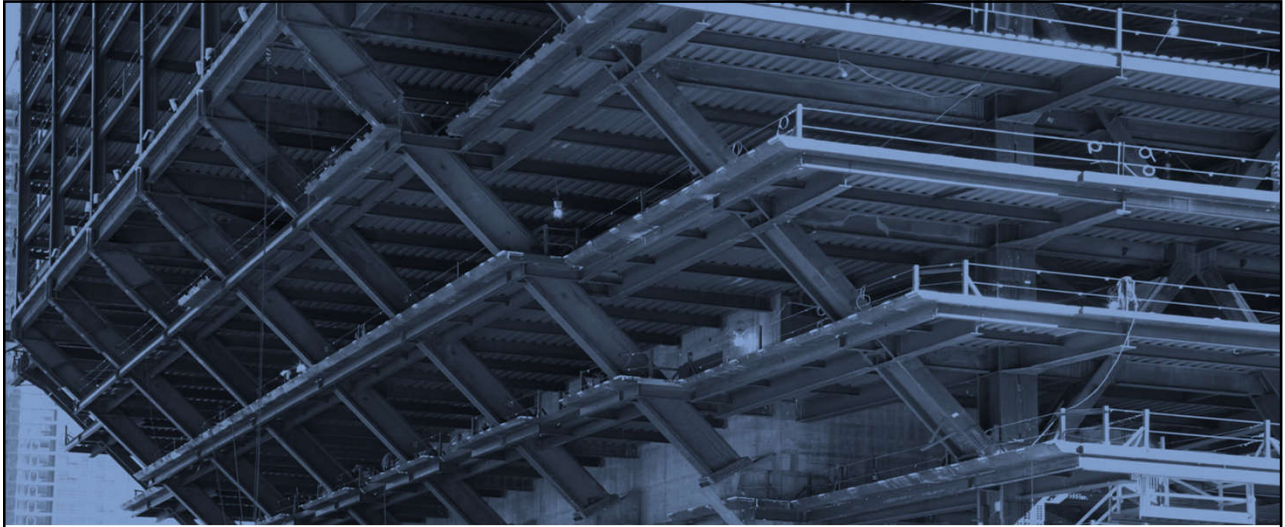
## 8-Session Registrants

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### Night School Resources

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





**AISC** | Thank you



Smarter.  
Stronger.  
Steel.