INSPECTION
OF
FIELD WELDING
Objective

- Types of Projects Involving Welding
- Common Welding Terms & Symbols
- Welder Qualifications
- Common Welding Requirements
- Welding Inspection
Types of Projects Involving Field Welding

- New Structures:
  - Bridge Rail
  - Strip Seal Extrusions / Armor Angles
  - Pile-to-Girder Connections
  - Pile splice
Types of Projects Involving Field Welding

- Rehabilitation Projects
  - Bridge Rail
  - Strip Seal Extrusions / Armor Angles
  - Fatigue Retrofits
  - Weld Repairs
Common Field Weld Types

- Fillet Welds
  - Fillet Weld

- Groove Welds
  - Square Groove Weld
  - V - Groove Weld
Symbols for Fillet Welds

- When symbol is below the line, the weld is to be placed on the side to which the arrow points.
Symbols for Fillet Welds

- When the symbol is above the line, the weld is to be placed on the opposite side of the joint to which the arrow is pointing.
Symbols for Fillet Welds

- **Weld symbols both sides of the line indicate that the weld is to be placed on both sides of the joint.**
Symbols for Groove Welds

- **Typical Groove Weld Symbols**

  - Arrow Side
  - Opposite Side
  - Both Sides
Additional Weld Markings

Field Weld

Weld All Around

Tail on end of weld is where any special instructions are placed
Surface Contours of Welds

It may be specified that the weld surface of a groove weld have a certain contour:

- **Weld Flush Without Grind**
- **Grind to Convex**
- **Grind to Flush**
Welding Positions

Flat Position

Horizontal Position
Welding Positions

Vertical Position

Overhead Position

Fillet Weld (3F)

Groove Weld (3G)

Fillet Weld (4F)

Groove Weld (4G)
Welding Positions

Side View

End View

Vertical

Horizontal

Weld

Flat

Overhead
Welding Positions

Side View

End View

May be either a flat, horizontal or overhead position depending on the rotation of the weld face.
May be either a vertical or an overhead position depending on the rotation of the weld face.

Welding Positions

Side View

End View
Welds at this incline are all vertical welds.
Welder Certification

- 2004 Standard Specifications Require that a Welder be Certified in Test Position 3G (Vertical) for Unlimited Thickness Groove Welds.
Welders Wanting to be Certified Need to:

- Tested in accordance with ANSI/AASHTO/AWS D1.5 Bridge Welding Code to at least 3G (vertical up)

- Qualification to ANSI/AWS D1.1 Structural Welding Code is **NOT** Acceptable.

(Refer to Section 410.3.H)
Welders Wanting to be Certified

Need to:

- Welder Qualification needs to be performed under the supervision of an AWS Certified Welding Inspector (CWI) and certified in accordance with AWS QC1.
  - Testing Firms
  - Vo-Tech Schools
Welding Electrodes

- Field welding is done with a covered electrode (Stick Electrode)
- SMAW (Shielded Metal Arc Welding)
  - Metal wire with a protective covering
  - Current is passed through the electrode.
    - This causes metals to melt and fuse together.
Welding Electrodes

- Only “Low Hydrogen Electrodes” shall be used.
  - E7016
  - E7018 ← Most Common
  - E7028

- Approved List or Certificate of Compliance.

- Electrodes exposed to the atmosphere will absorb moisture, therefore:
  - Electrodes in unopened original containers may be used directly from container.
  - Electrodes not used within 4 hours or brought to the job in open containers must be dried.
**Drying Electrodes**

- **Electrodes not used with 4 hours or from open containers shall be dried as follows:**
  - E7018  2 hrs. @ 450°F to 500°F

- After drying, store in storage ovens @ 250°F
- Reject Electrodes that have been wet.
Weather and Temperature

- Steel Must be preheated
- Welds shall not be placed when there is rain rain or snow
- Preheat will remove any water on cold days
For A36 and A709 Gr. 36 & Gr. 50:

<table>
<thead>
<tr>
<th>PLATE THICKNESS</th>
<th>MIN. INTERPASS AND PREHEAT TEMP °F</th>
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<tbody>
<tr>
<td>3/4” or Less</td>
<td>50</td>
</tr>
<tr>
<td>&gt;3/4” thru 1 1/2”</td>
<td>70</td>
</tr>
<tr>
<td>&gt;1 1/2” thru 2 1/2”</td>
<td>150</td>
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<tr>
<td>Over 2 1/2”</td>
<td>225</td>
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Preheat

- Carefully Review Plans/Shop Plans for Other Preheat Conditions.
  - Other Types of Steels May Require Higher Preheat.
  - High Restraint Details May Require Higher Preheat.
Preheat

Methods of Monitoring Preheat

• Surface Thermometer
• Thermomelt Stick
  – Thermomelt Sticks are made for several different temperatures.
  – Make sure proper stick is used.
Fillet Welds
Preparation of Base Metal

- **Weld Connection Area Must be Free of Defects and be Cleaned 2” Each Side of Weld:**
  - No loose mill scale, rust, oil, or grease
  - Galvanizing / Paint Removed
  - Moisture Free
Fit-Up of Plates With Fillet Welds

**Proper Fit-up and Weld Size**

- *Plate separations of 1/16” to 3/16” require leg of weld to be increased by the amount of separation.*
Fit-Up of Plates With Fillet Welds

- Separations of More than 3/16” Should Not be Allowed.
  - Contractor must correct
Alignment of Plates

- Plates Welded With Fillet or Groove Welds Need to be Held in Proper Alignment.

- Erection Bolts
- Tack Welds
- Clamps, Jacks, etc.
General Field Welding Procedures

- Use Flat Welding Position if Possible
- Vertical Welds from Bottom Up
- Remove Slag Between Passes
  - Chipping Hammer
  - Wire Brush
- Arc Must be Struck in Immediate Weld Area
**Inspection of Field Welds**

- **Most Field Welding is in Low Stress Areas.**
  - Visual Inspection

- **Welds in High Stress Areas are Much More Critical:**
  - Visual Inspection
  - Non-Destructive Testing
Visual Inspection

- **Groove Welds**
  - **Weld Reinforcement of 1/32” to 1/8”**
    - Except when a “Flush” weld is specified.
Visual Inspection

- Fillet Welds - Proper Size
  - Concave
  - Convex
  - Near Flat Preferred
Fillet Weld Gauge

Type of Gauge Used By Department of Transportation
Concave Fillet Weld

- Effective Size of Concave Fillet Weld Should be at Least the Weld Size Specified.
**Concave Fillet Weld**

- **Weld Size Measured With Fillet Gauge**
Convex Fillet Weld

- Weld Size Measured With Fillet Gauge
Weld Defects

- Types of Weld Defects:
  - Undercut
  - Overlap
  - Porosity
  - Cracks
  - Spatter
Undercut

**Undercut:**
Reduction in Base Metal
Thickness Alongside Weld

- **Causes:**
  - Excessive Current
  - Too Rapid of Welding Speed
  - Excessive Manipulation of Electrode
  - Electrode at Wrong Angle

- **Correction:**
  - Add Weld Metal at undercut.
Overlap

Overlap: Overflow Onto Base Metal Without Fusion.

Causes:
- Incorrect Current
- Too Slow Welding Speed
- Electrode at Wrong Angle

Correction:
- Remove Excess or Defective Weld Metal
  - Grinder
  - Air Carbon Arc
- Re-Weld to Correct Size
Porosity

Porosity:
Cavities Caused by Trapped Gases.

- Causes:
  - Excessive Moisture
  - Low Welding Current
  - Improper Arc Length

- Correction:
  - Remove Defective Weld
    - Grinding
    - Air Carbon Arc
  - Re-Weld to Proper Size
Cracks: Separation in Weld Metal or Adjacent Base Metal.

“All Cracks Must Be Repaired”

- **Causes:**
  - Shrinkage of Weld Metal and Resistance to Movement of Joined Parts.
  - Excessive Current With Rapid Cooling.
  - Low Air Temperature.

- **Correction:**
  - Remove Defective Weld
  - Re-Weld
Spatter

Spatter:
Small Pieces of Metal Scattered Over Weld Surface and Base Metal

**Causes:**
- Excessive Current
- Improper Arc

**Correction:**
- Remove Spatter With Wire Brush and/or Chipping Hammer
Seal Weld

- Occasionally Used to Seal Out Moisture
- Not a Structural Weld
- Should be Visually Inspected
Safty

- Do not watch the welding without a welding helmet
- Do not touch the red hot stuff