Specifications, Codes & Supporting Document: NCDOT Standard Specifications/AASHTO/AWS D1.4, PQR-030

Material Specifications: ASTM A615 Grades 75, 60 & 40, ASTM A706 Grade 60; Bar size 4 to 18 Inclusive


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

Manufacturer: NCDOT Approved

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

Root Treatment: N/A

Preheat Temp: Refer to preheat table below Interpass: 1100° maximum Post Heat: N/A

<table>
<thead>
<tr>
<th>Pass Num.</th>
<th>Electrode Size</th>
<th>Welding Current Amperes</th>
<th>Voltage Volts</th>
<th>Travel Speed IPM</th>
<th>Position</th>
<th>Joint Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>1/8&quot;</td>
<td>90-150</td>
<td>20-23</td>
<td>6-9</td>
<td>All</td>
<td>SEE ATTACHMENT</td>
</tr>
</tbody>
</table>

PREHEAT TABLE

<table>
<thead>
<tr>
<th>Rebar Size</th>
<th>Min. Temp.</th>
</tr>
</thead>
<tbody>
<tr>
<td>#6 or less</td>
<td>300°</td>
</tr>
<tr>
<td>#7 or larger</td>
<td>500°</td>
</tr>
</tbody>
</table>

COMMENTS:

Remove all coating, rust, dirt and mill scale within one inch of the area to be welded.
Pre-heat shall extend 6" in each direction beyond the joint.
Remove all slag, spatter and weld discontinuities between passes.
Check interpass temperature prior to the application of each pass.
Clean the completed weld of all debris, slag and spatter.

WPS Description: REBAR Indirect Butt Joint With Splice Angle

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

Signature: Randy Dempsey

WPS #: 062111030

Authorized By: Steve Walton, Metals Engineer

Revision #: 1

Signature:
Workmanship (AWS D1.4)

4.4 Quality of Welds

4.4.2 Any crack shall be unacceptable, regardless of size or location.

4.4.3 There shall be complete fusion between weld metal and base metal and between successive passes of weld.

4.4.4 All weld craters shall be filled to a cross section that meets the minimum specified weld size.

4.4.5 Welds shall be free from overlap.

4.4.6 Undercut depth greater than 1/32” in the solid section of the bar or structural member shall not be allowed.

4.4.10 The weld size shall be equal to or greater than the weld size specified. The length of weld containing this weld size shall be equal to or greater than the weld length specified. Any portion of the length, including starts or stops, that contain a smaller weld size shall not be measured in the weld length.
WPS REBAR Indirect Butt Joint with Splice Angle 062111030R1

JOINT DETAIL ATTACHMENT

- 3/4" max gap

weld size = 40 percent of the bar radius (min), or as directed by the plans

weld length = 2 times the bar diameter (min), or as directed by the plans

9/16" (5/16") 9°
Flare Bevel, Both Sides with Groove Depth, Weld Size and Length of Weld

FIELD WELD SYMBOL

Weld Symbol definitions per AWS A2.4i:2007
Illustrations for a rebar indirect butt joint with splice angle.

Joint fit-up.

Completed weld (3 passes).

A cross section was tested to verify that a 5/16" weld can be achieved with 3 passes using 1/8" E7018.

A tensile test was performed to verify that the integrity of the material was not compromised (a 500°F preheat and interpass temperature was maintained).

NCDOT MATERIALS & TESTS UNIT (STEEL SECTION)
North Carolina Department of Transportation  
Materials Tests Unit (Steel Section)  
Rebar Indirect Butt Joint with Splice Angle PQR 
Procedure Qualification Record No. PQR-030

Contractor: NCDOT Materials & Tests (Steel Section)  
Authorized By: Steve Walton  
Welder: Randy Dempsey, CWI/CWE  
Revision No.: 1  
Test Date: Monday, June 27, 2011

Welding Process:  
- [ ] FCAW-G  
- [ ] FCAW-S  
- [ ] GMAW  
- [x] SMAW  

PQR Joint Type:  
- [x] Indirect Butt T-Joint  
- [ ] Direct Butt  
- [ ] Indirect Butt  

Test Assembly:  
- [ ] Figure 6.5 A  
- [ ] Figure 6.5 B  
- [x] Figure 6.5 C  
- [ ] Figure 6.5 D  

Position:  
- [x] Joint Opening: [ ] 3/4" max  
- [ ] Groove Type: [ ] flare bevel  
- [ ] joint Opening: [ ] n/a  
- [ ] Root Face: [x] n/a  
- [ ] Backing: [x] yes, [ ] no  
- [ ] Backing Type: [x] double bevel  
- [ ] Backgouging: [x] yes, [ ] no  
- [ ] Backgouging Method: [x] n/a  
- [ ] Technique: [x] stringers, [ ] weave  

Electrical Characteristics:  
- [ ] Current: [ ] AC, [x] DCEP, [ ] DCEN  
- [ ] Transfer Mode (GMAW): [ ] Short-circuiting  
- [ ] globular  
- [ ] Spray  

Base Metal:  
- [ ] Material Specification: [ ] ASTM A615  
- [x] Grade: 60  
- [ ] Material Specification: [ ] ASTM A36-08/A529-05  
- [x] Grade: 60  
- [ ] Carbon Equivalent (Bar): [ ] not available  
- [ ] Bar Size: [ ] #6  
- [ ] Coated Bar: [x] yes, [ ] no  
- [ ] Type of Coating: [x] n/a  

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

Shielding:  
- [ ] Gas: [ ] single, [ ] mixture  
- [ ] Composition: [ ] n/a  
- [ ] Flow Rate: [ ] n/a  

Preheat/Interpass:  
- [ ] Preheat/Interpass Temperature (min): 300° F  
- [ ] Interpass Temperature (max): 1100° F  

Welding Parameters: 

<table>
<thead>
<tr>
<th>Pass Number</th>
<th>Electrode Diameter</th>
<th>Electrode Type</th>
<th>Amperage</th>
<th>IPM</th>
<th>Volts</th>
<th>Joint Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1/8&quot;</td>
<td>E7018</td>
<td>115</td>
<td>7</td>
<td>29</td>
<td>see attachment</td>
</tr>
<tr>
<td>2-3</td>
<td>1/8&quot;</td>
<td>E7018</td>
<td>110</td>
<td>8</td>
<td>29</td>
<td></td>
</tr>
</tbody>
</table>
**Visual Examination**

<table>
<thead>
<tr>
<th>Test Assembly Number One</th>
<th>Test Assembly Number Two</th>
</tr>
</thead>
<tbody>
<tr>
<td>X pass</td>
<td>X pass</td>
</tr>
<tr>
<td>fail (AWS) D1.4, Clause 4.4</td>
<td>fail (AWS) D1.4, Clause 4.4</td>
</tr>
</tbody>
</table>

Comments: Within tolerance of specifications.

**Tensile Test**

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>bar size</th>
<th>Area</th>
<th>Ultimate Tensile Load (lbs)</th>
<th>Ultimate Unit Stress (psi)</th>
<th>Character of Failure and Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>#6</td>
<td>0.44</td>
<td>47,954</td>
<td>108,986</td>
<td>approx. 3” outside the heat affected zone (see photo)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Specimen No.</th>
<th>Results</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>pass</td>
<td>A 5/16” weld was achieved with the application of 3 passes.</td>
</tr>
</tbody>
</table>

Welder's Name: Randy Dempsey, CWI/CWE

Welder ID No.: 2659 SCW

**Macroetch Test**

<table>
<thead>
<tr>
<th>Test Assembly Number One</th>
<th>Test Assembly Number Two</th>
</tr>
</thead>
<tbody>
<tr>
<td>pass</td>
<td>X pass</td>
</tr>
<tr>
<td>fail (AWS) D1.4, Clause 6.3.7.3</td>
<td>fail (AWS) D1.4, Clause 6.3.7.3</td>
</tr>
</tbody>
</table>

Welder: Richard Maxon, CWI

HiCams No.: 543029

We certify that the statements in this record are correct and that the welds were prepared and tested in accordance with the requirements of AWS D1.4, Structural Welding Code-Reinforcing Steel.

Contractor: NCDOT Materials & Tests (Steel Section)

Authorized by: Steve Walton

Date: Monday, June 27, 2011
NORTH CAROLINA DEPARTMENT OF TRANSPORTATION
MATERIALS AND TESTS UNIT
1801 BLUE RIDGE RD. RALEIGH, N.C. 27607
06/28/2011
Reinforcing Steel Test

Lab No.: F167530

Test No.: ASTM A615

<table>
<thead>
<tr>
<th>METRIC</th>
<th>RESULTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bar Size, in.</td>
<td>6</td>
</tr>
<tr>
<td>Nominal Area, sq. in.</td>
<td>0.44</td>
</tr>
<tr>
<td>Wt. Actual % of Theoretical</td>
<td></td>
</tr>
<tr>
<td>Yield Strength, P.S.I.</td>
<td>65756</td>
</tr>
<tr>
<td>Total Load, lbs.</td>
<td>47054</td>
</tr>
<tr>
<td>Tensile Strength, P.S.I.</td>
<td>109000</td>
</tr>
<tr>
<td>Elongation (8 in.), %</td>
<td></td>
</tr>
</tbody>
</table>

Comments:

V. O. Cordle
PHYSICAL TEST ENGINEER

cc:
0.44
6
ASTM A615

Page 1 of 1
Test Summary

Counter: 33967
Elapsed Time: 00:01:29
Heat Number: 
Lab:
Procedure Name: Rebar
Start Date: 6/28/2011
Start Time: 10:57:13 AM
End Date: 6/28/2011
End Time: 10:58:42 AM
Workstation: N.C. DOT
Tested By: owen

Test Results

Area: 0.4400 in²
Peak Load: 47954 lbf
Tensile Strength: 108986 psi
Halt of Force Yield: 65718.1800 psi