Resistance Butt Weld Splicing of Hoop Reinforcement for Columns and Shafts

Splicing Quality Control Manager

The Contractor shall designate in writing a Splicing Quality Control Manager (SQCM). The SQCM shall be responsible for the quality of all hoop reinforcement splicing, including the inspection of materials and workmanship, and submitting, receiving, and approving all correspondence, required submittals, and reports regarding hoop reinforcement splicing to and from the Engineer.

Splice Sample Test Facilities

Qualification testing and testing of production sample splices shall be performed at an independent qualified testing laboratory at no additional expense to the Contracting Agency. The laboratory shall have the following:

1. Proper facilities, including a tensile testing machine capable of breaking full size samples of all steel reinforcing bar splices.

2. Operators who have received documented training for performing the testing requirements of ASTM A 370.

3. A record of annual calibration of testing equipment performed by an independent third party that has standards that are traceable to the National Institute of Standards and Technology and a formal reporting procedure, including published test forms. Calibration records shall be made available for the Engineer’s review upon request.

Splice Qualification Report

The Contractor shall submit a Splice Qualification Report as a Type 1 Working Drawing. This report shall include, at a minimum:

1. Name of the designated Splicing Quality Control Manager (SQCM).

2. Splice material information

3. Names of the operators who will be performing the splicing

4. Descriptions of the positions, locations, equipment, and procedures that will be used in the splice work.

5. Fabricator’s Quality Control Manual for the fabrication of hoops including, but not be limited to, the following:

   a. The pre-production procedures for the qualification of material and equipment.

   b. The methods and frequencies for performing quality control procedures during production.
c. The calibration procedures and calibration frequency for all equipment.

d. The welding procedure specification for resistance welding.

e. The method for identifying and tracking lots.

6. Certifications from the fabricator for qualifications of operators and procedures based on sample qualification tests performed within the past 24 months of the date of the Splice Qualification Report submittal.

   a. Each operator shall be certified by performing two sample splices for each bar size of each splice type that the operator will be performing in the work.

7. Certified test results for all qualification sample splices, tested by an independent qualified testing laboratory and conforming to the specified production test criteria.

**Production Control Splice Test Criteria**

For the purpose of hoop reinforcement splice testing, a lot of splices are defined as 200, or a fraction thereof, of the same type of splice for each bar diameter that is used in the work. A production control sample shall consist of four splices removed from each lot of completed splices.

The Contractor shall select the splices comprising the lot. The Engineer will select the product control sample of four splices to be tested from each lot.

Production control testing shall be performed for all hoop reinforcement splices used in the work. Production control samples shall be tested in accordance with ASTM A 370.

**Sample Test Criteria**

After the splices in a lot have been completed, the SQCM shall notify the Engineer in writing that the splices in this lot conform to the specifications and are ready for testing.

At least one week before sample testing, the Contractor shall notify the Engineer in writing of the date and location of the testing.

Samples shall achieve at least 125 percent of the specified yield strength of the bar. In addition, either necking of the bar or a plateau of the stress-strain curve shall be evident at rupture.

**Sample Acceptance Criteria**

If all four sample splices from a lot conform to the requirements of the **Sample Test Criteria** subsection of this Special Provision, all splices in the lot represented by the test will be considered acceptable.
If only two or three of the four sample splices from a lot conform to the requirements of the Splice Test Criteria subsection of this Special Provision, the Engineer will select an additional set of four samples for re-test from the same lot of splices. Should any of the four sample splices from this additional test fail to conform to these requirements; all splices in the lot will be rejected.

Should only one sample splice from a lot conform to the requirements of the Splice Test Criteria subsection of this Special Provision, all splices in the lot will be rejected.

Whenever a lot of splices are rejected, the rejected lot and subsequent lots of splices shall not be used in the work until the following requirements are met:

1. The SQCM performs a complete review of the Contractor's quality control process for these splices.
2. A written report is submitted to the Engineer describing the cause of the failure of the splices in this lot and provisions for preventing similar failures in future lots.
3. The Engineer has provided the Contractor with written notification that the report and any corrective action is acceptable.

All bars within a lot shall be visually inspected to verify bar offset at the joint doesn’t exceed what is permitted in ANSI/AWS D1.4/D1.4M:2011 Section 4.2.1. Any splice with offsets exceeding those as specified in ANSI/AWS D1.4/D1.4M:2011 Section 4.2.1 will be rejected.

Reporting Test Results
A Production Control Test Report for all testing performed on each lot shall be prepared by the independent testing laboratory performing the testing and submitted to the SQCM. The report shall include the following information for each test:

1. Contract number.
2. Dates received and tested.
3. Lot number.
4. Bar diameter, hoop diameter, and bar length.
5. Type of splice.
7. Physical condition of the test sample splice and description of break and location in relation to splice.
8. Any noticeable defects.

9. Ultimate tensile strength of each splice.

The SQCM shall review, approve with a signature, and submit each Production Control Test Report as a Type 2 Working Drawing. The Contractor shall not encase the splices represented by the report in concrete until receiving the Engineer’s written response to the submittal.

Welded Direct Butt Splicing of Hoop Reinforcement for Columns and Shafts

Welded Direct Butt Splices
Welded direct butt splices shall be complete joint penetration butt welds conforming to ANSI/AWS D1.4/D1.4M figure 3.2. Split pipe backing shall not be used.

Thermite welding is not allowed.

Nondestructive Splice Tests
Radiographic examinations shall be performed on 25 percent of all complete joint penetration butt welded splices from a lot defined as 200, or a fraction thereof, of the same type of splice for each bar diameter that is used in the work.

All splices shall be 100 percent visually inspected.

All required radiographic examinations shall be performed by the Contractor in accordance with ANSI/AWS D1.4/D1.4M and as specified below.

Before radiographic examination, welds shall conform to ANSI/AWS D1.4/D1.4M Section 4.4. Radiographic acceptance shall be in accordance with ANSI/AWS D1.4/D1.4M Table 4.1. Acceptance criteria for bar size #7 shall be the same as for bar size #8.

Should more than 12 percent of the splices which have been radiographically examined in any lot be defective, an additional 25 percent of the splices, selected by the Engineer from the same lot, shall be radiographically examined. Should more than 12 percent of the cumulative total of splices tested from the same lot be defective, all remaining splices in the lot shall be radiographically examined.

All defects shall be repaired in accordance with ANSI/AWS D1.4/D1.4M, latest edition.

The Contractor shall notify the Engineer in writing a minimum of 48 hours before performing any radiographic examinations.

The radiographic procedure used shall conform to ANSI/AWS D1.1, ANSI/AWS D1.4/D1.4M Section 7.9, and the following:
1. Two exposures shall be made for each splice. For each of the two exposures, the radiation source shall be centered on each bar to be radiographed. The first exposure shall be made with the radiation source placed at zero degrees from the top of the weld and perpendicular to the weld root and identified with a station mark of "0". The second exposure shall be at 90 degrees to the "0" station mark and shall be identified with a station mark of "90". When obstructions prevent a 90 degree placement of the radiation source for the second exposure, and when approved in writing by the Engineer, the source may be rotated, around the centerline of the steel reinforcing bar, a maximum of 25 degrees.

2. If more than one weld is to be radiographed during one exposure, the angle between the root line of each weld and the direction to the radiation source shall not be less than 65 degrees.

3. Radiographs shall be made by either X-ray or gamma ray. Radiographs made by X-ray or gamma rays shall have densities of not less than 2.3 nor more than 3.5 in the area of interest. A tolerance of 0.05 in density is allowed for densitometer variations. Gamma rays shall be from the iridium 192 isotope and the emitting specimen shall not exceed 0.18 inches in the greatest diagonal dimension.

4. The radiographic film shall be placed perpendicular to the radiation source at all times; parallel to the root line of the weld unless source placement determines that the film shall be turned; and as close to the root of the weld as possible.

5. The minimum source to film distance shall be maintained so as to ensure that all radiographs maintain a maximum geometric unsharpness of 0.020 at all times, regardless of the size of the steel reinforcing bars.

6. Penetrameters shall be placed on the source side of the bar and perpendicular to the radiation source at all times. One penetrameter shall be placed in the center of each bar to be radiographed, perpendicular to the weld root, and adjacent to the weld. Penetrameter images shall not appear in the weld area.

7. When radiography of more than one weld is being performed per exposure, each exposure shall have a minimum of one penetrameter per bar, or three penetrameters per exposure. When three penetrameters per exposure are used, one penetrameter shall be placed on each of the two outermost bars of the exposure, and the remaining penetrameter shall be placed on a centrally located bar.

8. An allowable weld buildup of 0.16 inch may be added to the total material thickness when determining the proper penetrameter
selection. No image quality indicator equivalency will be accepted. Wire penetrameters or penetrameter blocks shall not be used.

9. Penetrameters shall be sufficiently shimmed using a radiographically identical material. Penetrameter image densities shall be a minimum of 2.0 and a maximum of 3.6.

10. Radiographic film shall be Class 1, regardless of the size of the steel reinforcing bars.

11. Radiographs shall be free of film artifacts and processing defects, including, but not limited to, streaks, scratches, pressure marks or marks made for the purpose of identifying film or welding indications.

12. Each splice shall be identified on each radiograph and the radiograph identification and marking system shall be established between the Contractor and the Engineer before radiographic inspection begins. Film shall be identified by lead numbers only; etching, flashing or writing in identifications of any kind will not be permitted. Each piece of film identification information shall be legible and shall include, as a minimum, the following information:

   a. The Contractor's name.

   b. The name of the nondestructive testing firm.

   c. Contract number.

   d. Date of the test.

   e. Initials of the radiographer.

   f. Part number.

   g. Weld number.

The letter "R" and repair number shall be placed directly after the weld number to designate a radiograph of a repaired weld.

13. Radiographic film shall be developed within a time range of one minute less to one minute more than the film manufacturer's recommended maximum development time. Sight development will not be allowed.

14. Processing chemistry shall be done with a consistent mixture and quality, and processing rinses and tanks shall be clean to ensure proper results. Records of all developing processes and any chemical changes to the developing processes shall be kept and furnished to the Engineer upon request. The Engineer may
request, at any time, that a sheet of unexposed film be
processed in the presence of the Engineer to verify processing
chemical and rinse quality.

15. The results of all radiographic interpretations shall be recorded
on a signed certification and a copy kept with the film packet.

Technique sheets prepared in accordance with ASME Boiler and Pressure
Vessels Code Section V Article 2 Section T-291 shall also contain the
developer temperature, developing time, fixing duration and all rinse
times.

The Contractor shall maintain the radiographs and the radiographic
inspection report(s) in the shop until the Engineer reviews them or
requests copies. If the Engineer reviews them in the shop then the film
and reports shall be released to the Engineer for permanent record
keeping at that time. If copies are requested, the Contractor shall submit
a Type 2 Working Drawing consisting of the film and a PDF or two paper
copies of the radiographic inspection report. Adequate facilities and
equipment shall be provided the Engineer for examining film, if performed
in the shop.

If the Engineer has not reviewed the film and reports in the shop or
requested copies within ten working days of completion of the lot, the
Contractor shall submit a Type 2 Working Drawing consisting of the film
and reports.

Welded Lap Splicing of Hoop Reinforcement for Shafts
All production splices shall be 100 percent visually inspected for weld quality,
size and length.