DESIGNER NOTES

*This Special Provision is intended to be used when existing structural steel is damaged by impact and is repairable by heat straightening. The Designer shall modify only the content highlighted in yellow as necessary to suit the project requirements.*

*DELETE ALL DESIGNER NOTES, AND REMOVE HIGHLIGHTING PRIOR TO SUBMITTAL*

**Heat straightening**

The work under this item shall consist of heat straightening the ***(****Designer shall: Identify girders. Identify areas of damage including distortion, flange tilt, cracks and deep gouges. Give measurements of distorted areas, flange tilt and crack sizes.)*

The work requires re-alignment of the web and bottom flange, as well as the correction of any flange tilt by means of an approved procedure, as described in the General Heat Straightening Requirements Section of these specifications.

The heat straightening specialist shall closely examine all areas surrounding the point of impact including secondary connections and adjacent diaphragm connections for cracking. If cracking exists, the specialist shall determine if the cracks should be repaired prior to or after straightening.

The tips of cracks in webs or flanges shall be located using Magnetic Particle Testing (MT). Cracks and torn areas of the web or flange shall be prepared for welding by air carbon arc gouging and grinding to an acceptable profile. All welding shall be performed in accordance with a welding procedure specification (WPS) approved by the Engineer. Upon completion of welding, these welds shall be inspected using ultrasonic testing (UT).

The extent of cracking in fillet welds shall be determined by Penetrant Testing (PT) or Magnetic Particle Testing (MT). All fillet weld repairs shall be inspected using MT.

**GENERAL REQUIREMENTS FOR HEAT STRAIGHTENING**

The heat applied shall be between 700 and 1200 degrees Fahrenheit for all but quenched and tempered steel. The temperature shall be monitored through the use of contact thermometers, pyrometric sticks or other suitable means. The maximum torch tip size shall be 1-inch diameter. A rosebud tip may be used for steel thickness in excess of 1 inch.

The heat straightening shall be accomplished through the application of V-heat, line heat and spot heat patterns. The angle formed at the apex of the v-heat pattern shall not exceed 20 degrees for thin members and may increase incrementally to 45 degrees for very thick members. The base of the v-heat pattern should preferably not exceed 10 inches. Heating shall be performed in such a manner that the only location showing "color" shall be directly under the torch tip. Heating shall start at the apex of the V-heat pattern and shall progress to the base. A heat pattern may not be reheated until the area has cooled completely.

Straightening operations may be accelerated by the use of external jacking devices. Jacks shall be applied before heating and not increased by external means during heating or cooling. Jacks shall not impede contraction during the cooling phase and they should not produce local buckling of the compression elements. Caution must be used in applying external forces, since over-jacking may result in fracture of the member. The forces applied through these jacking devices shall be limited such that the stresses in the member prior to heating operations do not exceed *(Designer shall specify one of the following stresses:* 18 ksi *for A7 steel*; 20 ksi *for Grade 36 steel*; 27 ksi *for Grade 50 steel*; 38 ksi *for Grade HPS 70W steel. If several bridges with different steels are to be heat straightened under this contract, identify each bridge and the maximum stress to be used for that bridge*).

A detailed heat straightening and repair procedure shall be submitted to and approved by the Engineer prior to the start of work. The heat straightening procedure shall be prepared in accordance with the FHWA report no. FHWA-IF-99-004, “Heat Straightening Repair of Damaged Bridges” as modified by the NCHRP Report 604 “Heat Straightening Repair of Damaged Steel Bridge Girders: Fatigue and Fracture Performance.” The procedure shall include, but is not limited to, calculations of stresses resulting from the applied external jacking loads used in the straightening operations; the approximate locations to which heat shall be applied; heat patterns and sequences proposed; general sketches of jacking system to be used; welding procedures; and MT and UT procedures.

Final straightness tolerances for plate girders shall meet the straightness requirements in the current edition of the AASHTO/AWS D1.5 Bridge Welding Code and the final straightness tolerances for rolled beams shall meet straightness requirements in ASTM A6" Standard Specifications for General Requirements for Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use",

All heat straightening shall be performed by an approved company and supervised by a Professional Engineer who is thoroughly familiar with heat straightening. The following is a list of companies approved for such work by the Department:

1. D L McQuaid & Assoc., Inc. Tel. No.  724-485-2373

David McQuaid Fax Phone No.  724-485-2376

Canonsburg, PA  15317 Cell Phone No. 412-596-2474

1. Flame On Tel. No. 425-397-7039

Monroe, Washington Fax No. 425-397-7002

1. National Bridge Company Tel. No. 517-347-6167

Dan Garijo Fax No. 517-347-3577

Okemos, Michigan Cell No. 517-202-4772

1. Dan R Dalton Inc. Tel. No. 509-447-3528

Dan Dalton Fax No. 509-447-3373

Usk, Washington Cell No. 509-993-3588

**STRUCTURAL STEEL REPAIRS**

Work shall conform to Section 960 of the Standard Specifications and the following:

Work under this heading includes, but is not limited to, welding, drilling, cutting, grinding, nondestructive testing (PT, MT, UT) and any other work that may be necessary to complete the specified structural steel repairs.

All new structural steel shall conform to *(Designer shall provide appropriate AASHTO specification and grade)*.

All welding and nondestructive testing shall conform to the latest edition, as of the bid opening date, of the ANSI/AASHTO/AWS D1.5 Bridge Welding Code. Welding Procedure Specifications (WPS) and Procedure Qualification Records (PQR) shall be approved by the Engineer prior to the start of welding. All welders shall be certified by the Department. All technicians performing nondestructive testing shall be approved by the Engineer.

The contractor shall locate the tips of cracks and tears in flanges and webs using magnetic particle testing and shall punch mark the steel to show the location of the end of the crack. Weld repairs shall be made within one month from the date of testing.

Gouges in the steel shall be ground smooth on a slope of 1:10. All grinding shall be in direction of stress (along the length of the beam). Gouges greater than 1/4 inch deep in edges of beams or plates shall be repaired by welding. Gouges greater than 1/16 inch on surfaces of the steel shall be repaired by welding. The filler metal shall extend 1/16 inch above the surface and shall then be ground smooth.

**WELD REPAIRS**

Welding shall be done by using a MassDOT approved welding procedure. The FCAW-S process shall not be used. Notification shall be given to the Engineer sufficiently in advance of performing the work to permit the scheduling of certified welding inspectors by the Department. Welding shall not be permitted without a Department inspector present.

Welders shall possess current certifications issued by the Department. Welders shall be qualified for all positions in unlimited thickness.

If welding with the SMAW process, all electrodes shall be brought to the jobsite in a hermetically sealed container. Immediately after opening, the electrodes shall be stored in ovens held at at least 250 degree F. If no oven is available, all E70 electrodes shall be discarded after 4 hours and all E80 electrodes shall be discarded after 2 hours.

If welding with FCAW or GMAW, all wire shall be protected from moisture and dirt. If the wire gets wet, it shall be discarded.

Preheat and interpass temperature controls are contiguous operation and shall not be interrupted until complete. The specified temperature controls are designated to reduce the possibility of hardening of the weld or heat affected zone due to unacceptable cooling rates. In addition, the elevated temperatures are specified to permit the diffusion of hydrogen that may inadvertently be trapped in the weld metal.

The minimum preheat and interpass temperature of the steel shall conform to the table below. The specified preheat and interpass temperature shall be maintained for a distance of 3 inches minimum in all directions from the repair areas. Temperature monitoring shall be done using crayons, direct reading thermometers or equally accurate devices.

MINIMUM PREHEAT AND INTERPASS TEMPERATURE (degreesF)

Thickness of Thickest Part at Point of Welding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Thickness  Base Metal | Up to and including ¾” | Over ¾” to 1- ½” | Over 1-½” to  2-½” | Over 2-½” |
| M270 Grade 36 | 100 | 150 | 200 | 250 |
| M270 Grade 50/50W | 100 | 200 | 250 | 300 |
| M270 Grade HPS 70W | 100 | 200 | 250 | 300 |
| ASTM A7 | 400 | 400 | 400 | 400 |

Aborted weld starts or arc strikes shall be removed by grinding before continuing. Arc strikes on the base metal shall be removed. On tension or reversal of stress members, a hardness test and magnetic particle inspection shall be performed on the area after grinding. The hardness shall be less or equal to Rockwell C30.

Welding shall not be done when the ambient air temperature in the vicinity of the weld is below 0 degrees F. Welding may be performed if supplemental heat and protection from the elements are sufficient to maintain a temperature above 0 degrees F. Welding shall not be performed in the rain unless the area to be welded is adequately protected from the weather. Steel that is wet shall be completely dried by preheating prior to welding.

**RECORDS**

Appropriate sketches, notes and photos shall be prepared to describe the repair at each location in the structure. These records shall be submitted to the resident engineer at the completion of the project.