

729-B-204 HEAT STRAIGHTENING OF STEEL MEMBERS IN THE FIELD

(Revised 06-18-20)

The Standard Specifications are revised as follows:

SECTION 729, BEGIN LINE 1, DELETE AND INSERT AS FOLLOWS:

SECTION 729 – ~~BLANK~~HEAT STRAIGHTENING OF STEEL MEMBERS IN THE FIELD

729.01 Description

This work shall consist of field-repairing damaged steel members by the planned and supervised application of limited amounts of localized heat and jacking forces, grinding, and drilling crack-arrest holes in accordance with 105.03.

729.02 Prequalification Requirement

The Contractor performing the heat straightening work shall hold a current prequalification certification from the Department with a work type of 0050, steel bridge beam heat-straightening, regardless of whether the value of the total work under contract from all sources is less than \$300,000.

MATERIALS

729.03 Materials

Materials shall be in accordance with the following:

<i>Organic Zinc Primer</i>	<i>909.02(a)2</i>
<i>Partial Paint System.....</i>	<i>619.09(b)</i>
<i>Structural Steel.....</i>	<i>910.02</i>

CONSTRUCTION REQUIREMENTS

729.04 Pre-Heat Straightening Inspection

Steel members shall be inspected by the Engineer and Contractor for impact damage such as but not limited to gouges, sharp dents, cracks, or other damage prior to any other work related to heat straightening commencing. All areas identified as having impact damage shall have the paint removed by abrasive blasting, hand tool cleaning, power tool cleaning, or water blasting. The existing coating shall not be removed by flame or heat. The steel members in the areas identified as having damage resulting from an impact shall be checked for fine cracks using liquid penetrant testing in accordance with ASTM E 165 or magnetic particle testing in accordance with ASTM E 709.

(a) NDT Testing and Reporting Requirements

The testing shall be performed on surfaces that are clean, dry, and free of contaminants such as oil, grease, rust, weld flux, spatter, paint, and any other contaminant detrimental to NDT testing. A minimum visible light having an intensity of 200 ft-candles and 2150 lux shall be provided.

The following requirements apply to magnetic particle testing. The yoke method shall be used. Half-wave rectified DC yokes shall demonstrate the ability to lift a 30 lb

steel block at 2 in. \leq yoke pole spacing \leq 4 in. and 50 lbs at 4 in. \leq yoke pole spacing \leq 6 in. AC yokes shall demonstrate the ability to lift a 10 lb steel block at 2 in. \leq yoke pole spacing \leq 4 in. and 50 lbs at 4 in. \leq yoke pole spacing \leq 6 in. Dry, non-fluorescent medium meeting the requirements of AMS 3040, SE-709 shall be used. The Contractor shall provide a test medium in contrasting color to the test part.

(b) NDT Personnel Qualifications

Personnel performing either the liquid penetrant testing or magnetic particle testing shall be qualified and certified in accordance with the American Society of Nondestructive Testing, ASNT, recommended practice SNT-TC-1A, or ANSI/ASNT Standard CP-189, and shall be a Level II Inspector.

(c) Results and Reporting

At the conclusion of the testing, the NDT testing technician shall provide a report of each impact location tested; one report per location. The following information shall be included in the report:

- 1. location of the test on the structure, using nomenclature matching the contract plans,*
- 2. date of examination and testing,*
- 3. technician's name, certification, and signature,*
- 4. examination results and findings. If no cracks are found, this shall be stated in the report,*
- 5. the medium used, manufacturer, and color, and*
- 6. a high quality photo with a scale reference and location label. The photo shall be taken immediately after the testing and the reports shall be submitted on a daily basis to the Engineer.*

The Contractor shall notify the Engineer no later than the end of each work day of any base metal or weld metal defects that require additional treatment.

729.05 Contractor's Work Plan

Upon completion of the pre-heat straightening inspection, the Contractor shall submit a written work plan for the following:

- (a) cleaning of, and existing coating removal from the work area and any other areas of concern discovered during the pre- heat straightening inspection;*
- (b) types of heat patterns at each location and sequences;*
- (c) jacking or other means used to augment the heat straightening process. Detailed information on the method used and the proposed force*

measurement system shall be included. The force measurement system shall have been calibrated within the past 12 months;

(d) disconnecting, supporting, and adjusting steel members, as required;

(e) cleaning method and painting system to be used following the heat straightening.

The Contractor shall receive written approval of the work plan from the Engineer prior to beginning any work described in the work plan.

729.06 Grinding

After the damaged areas have been checked for cracks or other damage as outlined above, all gouges, tears, and sharp dents shall be ground smooth. An area 3 in. larger than the impact area on each side of the location of the impact shall be ground to a smooth, bright metal surface to remove the cold-worked region of the steel resulting from the impact. Any weld toes within, or immediately adjacent to, the impact area shall be ground smooth with a die grinder. Cracks discovered in the pre-heat straightening inspection shall be ground out by excavating the crack into a dish-like shape, the sides of which shall approximate a 3:1 taper. If the crack is not removed after grinding approximately a 1/8 in. depth of steel or if prior to grinding, the crack appears to be excessively long, deep or wide, the Engineer shall be notified prior to any grinding. Under no circumstances shall the cracks be v-grooved, filled with welding material, and then ground smooth.

729.07 Surface Preparation of Area to be Heated

Before cutting or heating any steel member, paint shall be removed from inside the limits of the heat straightening area. Surface preparation shall be in accordance with 619.08(a) and either 619.08(d) or 619.08(h).

729.08 Equipment

All gas fueled heating equipment, force application devices, and accessories shall be supplied by the Contractor. Fuel for heating shall be an oxygen-fuel mixture. The fuel shall be acetylene, natural gas, or propane.

Heat application shall be by a torch designed for heating, not cutting, with single-orifice tips only, unless otherwise specified herein. The size of the tip shall be proportional to the thickness of the heated material. As a guide, the tip size is shown in the following table:

<i>Steel Member Thickness, t (in.)</i>	<i>Orifice Size</i>
<i>$t \leq 1/4$</i>	<i>3</i>
<i>$1/4 < t \leq 3/8$</i>	<i>4</i>
<i>$3/8 < t \leq 1/2$</i>	<i>5</i>
<i>$1/2 < t \leq 5/8$</i>	<i>7</i>
<i>$5/8 < t \leq 7/8$</i>	<i>8</i>
<i>$t > 7/8$</i>	<i>*</i>
<i>* multiple torches, rosebud, or multiple orifice tips may be used.</i>	

729.09 Suspension of Work

If adverse weather conditions such as rain, snow, or hail arise, or anything else causing unexpected or sudden cooling of the heated members, the Engineer may order the suspension of work. If a suspension of work is ordered, the Contractor shall immediately cease applying heat to the steel members. The suspension of work will only apply while adverse weather conditions exist at the project location. The Contractor shall not recommence work until directed by the Engineer.

729.10 Heat Application and Heat Patterns

The Contractor shall identify, by measurements, all yield zones and yield lines prior to starting heat straightening. The temperature of the steel member within a heat pattern during any heat straightening cycle shall be between the minimum and maximum temperature values for the respective type of steel shown in the table below.

Temperature, °F		Type of Steel Shown on the Plans (ASTM Classification Shown)
Minimum	Maximum	
850	950	A 709, grade HPS 100W
900	1000	A 709, grade 70W; A 709, grade HPS 50W; A 709, grade HPS 70W; A 852; A 913
950	1050	A 514; A 709, grade non-HPS 100/100W
1100	1200	A 7; A 36; A 242; A 373; A 440; A 441; A 529; A 572; A 588; A 709, grades 36, 50, 50S, and 50W; A 992

Temperatures outside the limits specified above will be cause for rejection and replacement of the steel member.

The Contractor shall provide and use one or more of the following devices to verify temperatures during heat straightening:

- (a) Contact pyrometer*
- (b) Infrared non-contact thermometer.*

The contact pyrometer shall be calibrated daily with temperature crayons prior to use. The infrared non-contact thermometer shall be calibrated every 12 months. Documentation showing the last date of calibration for the infrared non-contact thermometer shall be provided to the Engineer before use. Heat application shall not be performed unless at least one of the devices listed above is being used to verify the temperature of the steel member. Heat patterns and sequences shall be selected to match the type of damage and cross section shape.

Heat shall be applied within an included angle of 15 to 55°, but limited to a base width of 12 in. Sufficient number of heat patterns shall be used to eliminate chording effects, where chording effects are defined as straightening small portions of the damaged steel member. Each heat pattern shall be heated in a single pass. The entire heat pattern shall not be reheated until the steel member has cooled below 250°F. Only cooling with clean, dry air will be allowed. Cooling with compressed air will only be allowed after the steel member has cooled naturally to 600°F. When the steel member thickness exceeds 1

in., two torches shall be used simultaneously to heat both sides of the heat pattern. The torches shall be located one above the other throughout the heating process.

The number, location, and sequence of the areas to be heated shall be marked on the steel members. The following heat patterns shall be used:

- (a) edge heats*
- (b) line heats*
- (c) spot heats*
- (d) strip heats*
- (e) vee heats.*

Heat pattern boundaries shall be marked with soapstone. In no case shall heat be applied to undamaged portions of the steel member.

When using vee heats, the heat pattern shall be located on the convex side of the steel member; heat pattern edges shall not overlap and shall be greater than the width of the bottom flange element apart. The apex of the vee should be truncated to an approximate 1 in. width at the junction of the web and flange with the boundaries extending to the edge of the flange. Once the desired temperature of the steel member has been obtained, heating shall progress in a serpentine motion from the apex of the vee toward the base of the vee in a single pass.

729.11 Application of Restraining Forces

Restraining forces shall not be applied without acceptable force measurement systems in place. Force measurement devices shall be calibrated every 12 months. Jacks or come-alongs, not exceeding 25 t capacity, may be used to put steel members into limited compression as a means of mechanically augmenting the heat straightening process. The load shall be applied prior to the application of heat. The load shall not be increased during the heat cycle. After a number of heat cycles and the steel member has cooled below 250°F, the load may be adjusted to compensate for the effects of the heat cycles. Any section of the steel member that becomes distorted, cracked, or permanently deformed due to methods of handling, supporting, and loading or by any other means shall be replaced or repaired as determined by the Engineer.

729.12 Tolerances

The steel member shall be straightened to within the following tolerances:

<i>Criteria</i>	<i>Tolerance</i>
<i>Horizontal Sweep</i>	<i>3/8 in. per every 20 ft of length</i>
<i>Horizontal Sweep at the point of impact</i>	<i>3/8 in. per every 5 ft of length, or 1/2 in. per every 8 ft of length</i>
<i>Vertical Deflection</i>	<i>1/4 in. maximum</i>
<i>Deflection of Web (out of plane of web)</i>	<i>1/4 in. maximum in both the vertical and horizontal direction</i>

Tolerances shall be achieved before cross frames, diaphragms, or any other lateral restraint devices are attached. In no case shall the steel member be forced into position and then welded or bolted to the cross frames or diaphragms to hold the steel member in position.

729.13 Post-Heat Straightening Inspection

Following the completion of steel member straightening, the straightened steel member shall be inspected by the Engineer and the Contractor. The inspection shall be performed using the same methods and procedures used in the pre-heat straightening inspection, including performing NDT.

729.14 Epoxy Injection

If the top flange of the steel member has pulled away from and is no longer in contact with the concrete bridge deck, the resultant void shall be completely filled by epoxy injection in accordance with 727 after completion of all of the steel member straightening and repairs.

729.15 Painting

Upon completion and acceptance of the heat straightened steel members, the Contractor shall clean, prime, and paint the steel members. Surface preparation shall be in accordance with 729.07. The paint system shall be in accordance with 619.09(b). Painting shall be in accordance with 619.10. All exposed surfaces on heat-straightened steel members shall be fully painted from the edge of the nearest splice plate or steel member end outside the heat straightened area to the nearest splice plate or steel member end on the other side of the heat straightened area. The color of the top coat shall be a similar color to match the color of the existing bridge.

729.16 Method of Measurement

Heat straightening, grinding, drilling crack-arrest holes, NDT testing, and other incidentals will not be measured for payment.

New structural steel and drilled holes for installation of bolts will be measured in accordance with 711.72.

729.17 Basis of Payment

New structural steel and drilled holes for installation of bolts will be paid for in accordance with 711.73.

The accepted heat straightened steel members will be paid for at the contract lump sum price for straighten steel member.

Payment will be made under:

Pay Item

Pay Unit Symbol

Straighten Steel MemberLS

The cost for all material, labor, equipment, and incidentals for the inspection of the steel members, the temperature verification devices, calibration of the temperature verification devices, grinding, and drilling crack-arrest holes if shown on the plans or directed by the Engineer, shall be included in the cost of straighten steel member.

The cost for all NDT activities, including but not limited to all material, equipment, and labor necessary to clean the test areas, perform and interpret NDT, and preparation of all NDT reports shall be included in the cost of straighten steel member.

The cost for all materials, labor, equipment, and incidentals necessary for disconnecting, supporting, or adjusting the steel members or secondary steel members, jacks or other augmenting devices, the force measurement system, and calibration of the force measurement system shall be included in the cost of straighten steel member.

The cost for all materials, labor, equipment, and incidentals required for existing coating removal, preparing, priming, and painting of the steel members shall be included in the cost of straighten steel member.

If the Engineer deems it necessary for the Contractor to perform epoxy injection as outlined above, this extra work will be paid for in accordance with 109.05.

If, as a result of the Contractor's methods used in the prosecution of the work, the integrity of the steel member has been compromised as determined by the Engineer, all costs to remedy the situation up to and including replacing of the steel members and all costs associated with replacing the steel members shall be at no additional cost to the Department.
