

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

(Adopted 09-19-13)

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 in accordance with 105.03. It shall include furnishing and installing or removing structural steel materials, as directed, in accordance with 105.03.*

**MATERIALS**

**729.02 Materials**

*Materials shall be in accordance with the following:*

<i>Organic Zinc Primer.....</i>	<i>909.02(a)2</i>
<i>Structural Steel.....</i>	<i>910.02</i>
<i>Waterborne Finish Paint.....</i>	<i>909.02(d)</i>

**CONSTRUCTION REQUIREMENTS**

**729.03 Pre-Heat Straightening Inspection**

*Damaged 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 resulting from the impact prior to any other work related to heat straightening commencing. All areas identified as having impact damage shall have the paint removed by using only a chemical-based paint-stripping product. Power tool cleaning, hand tool cleaning, or any other method to remove paint shall not be used. The steel members in the areas identified as having impact damage shall be checked for fine cracks using liquid dye penetration in accordance with ASTM E 165 or magnetic particle testing in accordance with ASTM E 709.*

**729.04 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 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.*

#### **729.05 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. 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.*

#### **729.06 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), 619.08(b), and either 619.08(d) or 619.08(g). Hand tool cleaning or brush-off blast cleaning shall not be used.*

#### **729.07 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><math>t \leq 1/4</math></i>	<i>3</i>
<i><math>1/4 &lt; t \leq 3/8</math></i>	<i>4</i>
<i><math>3/8 &lt; t \leq 1/2</math></i>	<i>5</i>
<i><math>1/2 &lt; t \leq 5/8</math></i>	<i>7</i>
<i><math>5/8 &lt; t \leq 7/8</math></i>	<i>8</i>
<i><math>t &gt; 7/8</math></i>	<i>*</i>
<i>* multiple torches, rosebud, or multiple orifice tips may be used</i>	

#### **729.08 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.*

### **729.09 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.*

<i>Temperature, °F</i>		<i>Type of Steel Shown on the Plans (ASTM Classification Shown)</i>
<i>Minimum</i>	<i>Maximum</i>	
850	950	<i>A 709, grade HPS 100W</i>
900	1000	<i>A 709, grade 70W; A 709, grade HPS 50W; A 709, grade HPS 70W; A 852; A 913</i>
950	1050	<i>A 514; A 709, grade non-HPS 100/100W</i>
1100	1200	<i>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</i>

*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) Pyrometer*
- (b) Infrared non-contact thermometer*

*The devices shall be calibrated every 12 months. 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 degrees, 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 permitted. Cooling with compressed air will only be permitted 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.

#### **729.10 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.

#### **729.11 Tolerances**

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

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

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.

**729.12 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. When the Engineer deems additional structural repairs are required, additional work shall be in accordance with 109.05.

**729.13 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.

**729.14 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 729.06. 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.

**729.15 Method of Measurement**

This work will not be measured for payment.

**729.16 Basis of Payment**

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:

<b>Pay Item</b>	<b>Pay Unit Symbol</b>
Straighten Steel Member .....	LS

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, and removal of any cracks 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 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.*

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