



**SPECIAL PROVISIONS
FOR
HEAT STRAIGHTENING OF BRIDGE BEAMS**

**Linn County
IMN-380-6(511)31--0E-57**

**Effective Date
September 29, 2026**

THE STANDARD SPECIFICATIONS, SERIES 2023, ARE AMENDED BY THE FOLLOWING MODIFICATIONS AND ADDITIONS. THESE ARE SPECIAL PROVISIONS AND THEY SHALL PREVAIL OVER THOSE PUBLISHED IN THE STANDARD SPECIFICATIONS.

230450.01 DESCRIPTION.

This work is to permanently repair damaged Continuous Welded Girder Sections in Span 3 of the Hagerman Road bridge over I-380, in Linn County. This bridge was damaged by an over height vehicle. The damaged bottom flange and web of the girders shall be repaired by heat straightening to restore them to the original shape and alignment. Certain intermediate steel diaphragm connection plates and transverse stiffeners as shown in the plans, shall also be repaired by heat straightening.

230450.02 EXPERIENCE REQUIREMENTS.

Prior to beginning work, submit to the Engineer documentation of 10 or more years of experience in the field of heat straightening major structural elements on highway or railroad bridges and a documented list of at least three bridge structures that have been successfully heat straightened.

230450.03 NOTIFICATION AND PRELIMINARY WORK.

- A.** Notify the Engineer 2 weeks prior to the starting date of heat straightening operations.
- B.** Prior to blast cleaning of the structural steel, the Contractor and the Engineer shall inspect the damaged section for gouges, sharp dents, cracks, or other impact caused defects and document any damage observed. If additional cracks are found other than those noted in the plans, the Iowa DOT's Bridges and Structures Bureau will be informed by the Engineer prior to the Contractor proceeding with the repair.
- C.** In accordance with the plans, blast clean the portions of the beams that have been damaged and require heat straightening. Heat straighten the existing flanges and webs to restore them to the original shape and alignment.

230450.04 REPAIR BEAM, HEAT STRAIGHTENING.

- A.** A jack or come-along may be used to mechanically augment the heat straightening process.
- 1.** The maximum magnitude of the jacking forces shall either be limited to 4 tons or per FHWA-HIF-23-003 "Manual for Heat Straightening, Heat Curving, and Cold Bending of Bridge Components":
 - a.** Jacking shall be limited so that the maximum bending moment in the heated zone shall be less than 50% of the plastic moment capacity of the member or major bending element. For local damage, the jacking force shall be limited to 50% of initial yield of the element.
 - b.** For cases where residual moments exist, the jacking moment should be limited in accordance with Equation 14 in Section 2.3.4.4 of FHWA-HIF-23-003. As an alternative to considering residual moments, the moment due to jacking forces can be limited to 25% of the plastic moment capacity of the member during the first two heating cycles. For additional heating cycles, the limit of 50% may again be used.
 - c.** Jacking applied to composite members shall be limited so that the sum of bending moments in the lower flange resulting from the applicable portion of the jacking force and estimated residual moments shall be less than 33 percent of the plastic moment capacity of the lower flange about its strong axis in accordance with Section 3.3.4 of FHWA-HIF-23-003. As an alternative to considering residual moments, the lower flange moment resulting from the applicable portion of the jacking force can be limited to 16% of the plastic moment capacity of the lower flange during the first two heating cycles. For additional heating cycles, the limit of 33 percent again may be used.
 - 2.** If maximum jacking forces above 4 tons are calculated, the calculations shall be signed and sealed by a Professional Engineer licensed in the State of Iowa and submitted to the Engineer for approval. A sketch showing the placement of the jacks and jack supports shall be included with the calculations submittal.
 - 3.** Jacks shall be placed so that forces are relieved as straightening occurs during cooling. Loading shall be judiciously applied to the beam during the straightening process. The jacking force shall not be adjusted during heating or before the temperature in the beam has cooled to 600°F or less. Adequately brace the adjacent beams at the jacking locations in order to prevent overloading due to applied lateral loads.
- B.** Heating shall be done using No. 8 or smaller torch tips on an oxygen-acetylene gas mixture. Vee, line, or spot heating patterns shall be conducted to bring the steel within the planned pattern to a temperature between 600°F and the limits shown below to produce deformations of the steel member conforming to the tolerances outlined on the plans and these special provisions. After the beam has been heat straightened, the heating pattern used shall be furnished to the Engineer for informational purposes. In no case shall the temperature exceed the limits defined below as determined with use of temperature indicating crayons, liquids, or a bimetal thermometer. The temperature of the steel during heat straightening shall not exceed the following per FHWA-HIF-23-003 "Manual for Heat Straightening, Heat Curving, and Cold Bending of Bridge Components":

Table 230450.04-1: Summary of Maximum Heat Straightening Repair Temperatures

<u>Material</u>	<u>Grades</u>	<u>Maximum Heat Straightening Temp. (°F)</u>
Non- Q&T ¹ Carbon Steels	All	1,200 ²
ASTM A709	36, 50, 50W, 50S, HPS 50W	1,200 ²
Q&T ¹ ASTM A709	HPS 70W, HPS 100W	1,100 ²
ASTM 514	-	1,100 ³

<u>Material</u>	<u>Grades</u>	<u>Maximum Heat Straightening Temp. (°F)</u>
ASTM 913	50, 60, 65, 70	1,100 ³
ASTM 913	80	1,000 ³
F3125 and F3148 Bolts	All	800 ³

¹ Quenched and tempered steel.

² These temperatures are from AASHTO/AWS 2016, which is incorporated by reference in CRF (23 CRF 625.4(d)(2)(i)).

³ These temperatures are suggestions, not Federal requirements.

- C. Provide the Engineer with temperature indicating crayons manufactured for all temperatures required to control the heating of the steel with visual observation, including but not limited to: 600°F (for compressed air cooling limit in Article 230450.04, E) and 1300°F, 1150°F or 1100°F (for the steel type heating limits of 1200°F, 1100°F & 1050°F shown respectively in Article 230450.04, B). Temperature verification during heat straightening may also be documented using infrared non-contact thermometers provided to the Engineer.
- D. The temperature of the heated metal may be determined by the color of the steel adjacent to the tip of the torch by using temperature crayons to correlate the temperature of the heated metal to the color of the steel. In normal daylight conditions, 1200°F will be indicated by a satiny, silver color near the torch tip. After cooling, the area should be gray in color.
- E. Only quenching with clean dry air will be permitted. Cooling with compressed air may be done only after the steel has cooled naturally to at least 600°F. Cooling shall be uniform throughout the heated area.
- F. Reheating or re-jacking of steel shall be performed only after the material has cooled to temperatures below 250°F.
- G. After the heat straightening has been completed, the Engineer will visually inspect the repaired beam. At the Engineer's discretion, nondestructive testing of the structural steel and weld may be performed if cracks are suspected. The Contracting Authority will do all testing.
- H. A work plan shall be submitted to the Engineer including but not limited to; a list of equipment to be used, a written description of the means and methods that will be used to accomplish the work, the maximum jacking forces to be used, the maximum heating temperature to be used for each component and the corresponding material and grade, and methods of measuring steel temperatures during heating.

230450.05 TOLERANCES.

The dimensions of heat-straightened structural members shall conform to the tolerances specified in the table below:

Table 230450.05-1: Tolerances for Heat Straightening Repair

Member Type	Tolerance 1,2
Beam/Girder overall at impact point	1/2 inch over 20 ft
Local Web Deviations	d/100 but not less than 1/4 inch or more than 1/2 inch
Local Flange Deviations	b/100 but not less than 1/4 inch or more than 1/2 inch

1 Units of member depth, d, and flange width, b, are inches

2 Tolerances for curved or cambered members should account for the original shape of the member

230450.06 PERFORMANCE.

If the alignment of the beam is not straightened to within the tolerances specified or if any portion of repaired beam or surrounding structure is damaged as a result of the heat straightening process or jacking procedure, replace or repair the portions of the beam as determined by the Bridges and Structures Bureau of the Iowa DOT. The cost of repair or replacement with a new section of beam, associated materials, and labor shall be borne by the Contractor at no cost to the Contracting Authority.

230450.07 METHOD OF MEASUREMENT.

The Contractor will be paid the lump sum contract price bid for Repair Beam, Heat Straightening, As Per Plan.

230450.08 BASIS OF PAYMENT.

The Contractor shall be responsible for all costs associated with heat straightening to repair the bridge beams, including furnishing all labor, materials and equipment required to heat straighten all damaged portions of the beams to their original alignment as noted herein. This includes furnishing all jacks and temporary bracing needed in the heat straightening process.