Section 713. BRIDGE REHABILITATION — STEEL

713.01. Description. This work consists of repairing and replacing portions of structural steel bridges.

A “redundant structure” consists of supporting elements that provide an alternate stress path if one element fails or is taken out of service; the loss of supporting elements in a “nonredundant” structure will cause failure of the complete structure.

713.02. Materials. Provide materials in accordance with the following:

Concrete, Grade S2	701
Steel Reinforcement, Grade 60	905
Structural Steel	906
High Strength Bolts, Galvanized A 325	906
Structural Timber and Lumber	912

A. **Steel for Temporary Supports.** Provide temporary hanger rods that meet the requirements of ASTM A 193 Grade B7 (AISI 4140). Provide rods with longitudinal Charpy V-notch impact values of 50 foot-pounds at 30 °F. If necessary, heat treat steel to meet the Charpy V-notch impact requirements. The Engineer will reject rods with notches, nicks, or welds.

Provide a sample 15 inches long, saw cut from each bar length used for hanger rod fabrication. Provide adequate notice to allow a Department representative to witness the removal of samples from each bar length. The Department will use these samples for tensile strength, yield strength, and impact testing. Reduce the sample length to 8 inches, for impact testing only, if providing a Certified Mill Test Report, traceable to the material. Match-mark each bar sample and corresponding remainder, by stenciling in the end cross-section.

The Engineer will base rod material acceptance on Department testing and traceable Certified Mill Test Reports.

Provide heavy hex nuts for the temporary hanger rods in accordance with ASTM A 563 Grade DH or ASTM A 194 Grade 2H, and washers in accordance with ASTM F 436.

Provide steel for temporary supports in accordance with AASHTO M 270 Grade 36 and section 906.

B. **Sealant for Perimeter of Beam Plates.** Select the sealant from the Qualified Products List. Provide sealant in caulking tubes.

713.03. Construction.

A. **Providing and Fabricating Structural Steel.** Provide and fabricate structural steel additions and replacements for existing structures and steel portions of temporary supports in accordance with section 707. Submit shop drawings to the Engineer for approval before fabrication.

Measure the pin dimensions of existing link plates from center-to-center. If pin dimensions differ by more than ⅛ inch from the dimensions shown on the plans, build replacement link plates to existing dimensions instead of plan dimensions. The Engineer will direct changes to plan dimensions to fit existing dimensions.

Submit to the Engineer, a final report on the pin and hanger assemblies that lists the as-built dimensions of the new link plates and pins. Demonstrate that tolerances meet the requirements specified in subsection 707.03.C.12. Install bushings in accordance with subsection 707.03.C.13. Assemble and ship pin and link plate pairs as a unit or match mark pairs.

B. **Temporary Supports for Girder Ends.** Use plan drawings, or propose an alternate design and obtain the Engineer's approval, for temporary supports for girder ends. Base alternate designs on loads and allowable soil pressures shown on the plans. Include calculations for alternate designs in the alternate design submittal. Ensure alternate designs maintain redundancy and material safety factors specified in AASHTO LFRD Bridge Design Specifications. Ensure a professional engineer, licensed in the state of Michigan seals alternate designs.

The Department reserves the right to verify structural adequacy of fabricated temporary support systems used. Verification may include visual inspection and nondestructive testing by Department personnel. The Department may require mill test report submittals for material and shop drawings of original fabrication. Before using temporary supports, make corrections deemed necessary by the Department.

Provide hydraulic jacks with a stroke of at least 3 inches and pumps capable of extending jacks full stroke. Equip hydraulic systems with dial gauges that enable determination of the external loads.

Provide hydraulic jacks with locking rings or other positive locking devices to prevent settlement in case of hydraulic failure. Use locking devices during and after jacking cycles until placement of stable shims and removal of loads from jacks.

Maintain temporary support, including replacing supports in case of partial or complete failure. The Department reserves the right to provide

labor, materials, and supervision to restore movement of traffic if the Contractor delays or makes inadequate progress in the repair or replacement of a temporary support, at no additional cost to the Department.

1. **Column-Type Supports.** After erection, before loading temporary supports, use a plumb line to determine the horizontal offset of the top of the column from the bottom of the column. Determine the horizontal offset of the hydraulic jack from the column centerline. Measure the column and hydraulic jack offsets parallel and perpendicular to the column web. Place jacks and temporary supports at each location so individual offsets and the sum, in each measured direction, do not exceed 1 inch. Consider jack offsets positive, regardless of column offset directions.

   If structure embankment (CIP) is not required by the contract, compact the natural ground 9 inches deep, to at least 95 percent maximum unit weight before placing temporary supports.

   If placing temporary supports on paved shoulders or roadways, place a leveling course of 21AA aggregate, asphaltic cold-patch, or other material approved by the Engineer. Compact leveling material to 95 percent maximum unit weight before placing temporary supports.

   The Engineer may direct bracing of temporary supports, based on Contractor methods for performing rehabilitation work.

   Leave jacks in place until installation and operation of link plates and pins. The Contractor may disconnect lines and pumps provided the equipment remains on the project.

   During the first 4 hours after loading, check hourly for settlement of temporary supports. Make subsequent settlement checks daily. To prevent girder ends from subsiding more than $^{1}/_{16}$ inch from the original position, correct by adding shims to temporary supports.

2. **Suspension-Type Supports.** After placing stable shims, the Engineer may approve removing jacks.

   Repair concrete removed for erecting temporary support or access to the girder end, as approved by the Engineer.

3. **Diaphragm-Type Supports.** Place temporary supports on substructure units as shown on the plans. Equally load and simultaneously advance hydraulic jacks placed in pairs.

Leave jacks in place until repair or replacement and operation of structural components. The Contractor may disconnect lines and pumps provided the equipment remains on the project.

Propose grouting material and placement procedures to the Engineer for approval. Place grout on substructure units to create a smooth and level bearing surface for temporary supports. Select an H-1 grout material in accordance with section 702. Form the space for grouting and clean the surface. Mix, place, and cure grout material in accordance with the manufacturer's recommendations. After curing, remove forming material to allow the Engineer to inspect the grouted space. Do not apply load to grout until the grout attains a minimum compressive strength of 4,000 psi.

C. **Pin and Hanger Replacement.**

1. **Measurement of Existing Hanger Assemblies.** Take field measurements of hanger assemblies requiring replacement and submit as-built dimensions, and a drawing showing the measured span and girder end, to the Engineer.

   Measure existing pin diameters, the distance between pins from center-to-center, and the length, width, and thickness of link plates.

   Check girder web alignment by laying a straight edge across pin plate gaps at the top and bottom of the girder. Measure and report girder offsets.

   Close lanes or shoulders to allow field measurements in accordance with the Michigan Manual of Uniform Traffic Control Devices and the contract documents. Obtain the Engineer's approval for lane and shoulder closures. Do not leave lanes or shoulders closed overnight for field measurements.

2. **Removal of Existing Hanger Assemblies.** Remove existing hanger assemblies as shown on the plans and in accordance with subsection 204.03.A.5 and this subsection.

   If removing and replacing link plates and pins from more than one girder at a time, do not work on the same end of adjacent girders. Ensure suspenders remain operational on the girder end opposite removed link plates or pins.

   Support girder ends on stable shims, without using hydraulics, before removing components. Remove two pins and two link plates in each assembly. Cut the link plates and pins for removal in accordance with the following:

a. Cut link plates into two pieces with a sloping transverse cut that coincides with the joint opening between girder ends. If cutting link plates at the pin, position a sheet metal shield behind link plates to protect the girder.
b. Place a metal heat shield around pin holes before flame cutting pins. The Contractor may trim pin ends to within no less than 1 inch of girder pin plates. The Contractor may burn a hole through the center of pins to ease removal. If pin removal gouges a hole in girder pin plates, grind plates smooth before blast cleaning and coating. Obtain written approval from the Engineer for welding repair of girder pin plate holes.

3. **Installation and Coating of New Hanger Assemblies.** If end diaphragms prevent installation of new pins, flame cut an oblong hole in the web of one end diaphragm using as a cutting guide, at least a ⅛-inch thick steel hole template, clamped to the channel section. After flame cutting, grind hole edges to a surface roughness no greater than 125 micro-inches per inch root mean square (rms). Clean and coat holes and leave in the finished structure. Do not loosen or remove end diaphragms.

   After removing pins, grind notches and deep pits in the girder pin plate around the periphery of the hole to a surface roughness no greater than 125 micro-inches per inch rms. Clean and coat girder ends, within 3 feet of each side of the centerline of pin holes or to the nearest stiffener, before installing new hanger assemblies. Clean and coat in accordance with section 715.

   Assemble new hanger assemblies before removing falsework shims.

D. **Bearing Stiffeners at Temporary Supports.** Erect bearing stiffeners at temporary supports in accordance with section 707. Leave stiffeners in place as a permanent part of the structure. Field drill bolt holes in existing girders; do not flame cut or air arc gouge existing girders or proposed attachments. Complete field drilling before blast cleaning and prime coating faying surfaces.

Before erecting bearing stiffeners, clean and coat faying surfaces and other contact surfaces. Faying surfaces consist of surfaces internal to a connection that bear on an adjacent surface. Clean and coat faying surfaces and other contact surfaces in accordance with section 715.

After bolting bearing stiffeners in place, clean and coat exposed areas in accordance with section 715. The Contractor may perform this cleaning and coating immediately after erection or during cleaning and coating of the remainder of the girder.

E. **Retrofit Structural Steel.** Erect retrofit structural steel in accordance with subsection 707.03.D. Leave retrofit structural steel in place as a permanent part of the structure. Field drill bolt holes in existing steel; do not flame cut or air arc gouge the existing steel or attachments. Complete field drilling before blast cleaning and prime coating faying surfaces.

Before erecting retrofit structural steel, clean and coat faying surfaces and other contact surfaces. Clean and coat retrofit structural steel in accordance with section 715.

After bolting structural steel in place, clean and coat the exposed areas in accordance with section 715. The Contractor may perform this cleaning and coating immediately after erection or during cleaning and coating the remainder of the girder.

F. **Sealing the Perimeter of Beam Plates.** Before applying sealant, clean and dry surfaces between repair plates or angles and beams and other surfaces requiring sealant. Apply sealant around the perimeter of bolted or riveted plates or angles on steel beams, as directed by the Engineer. Apply sealant over the intermediate coat when dry to the touch.

Apply sealant when air and surface temperatures are above 40 °F. Immediately after applying sealant, tool to form a 5/16-inch fillet and force it against contact surfaces. Completely fill pits and depressions in steel beams at the seam line with sealant, regardless of width and depth. Apply a top coat over sealant after the intermediate coat cures.

G. **Heat Straightening Damaged Structural Steel.** Heat straighten damaged structural steel under the direct on-site supervision of a specialist in heat straightening bridge structural steel. This specialist must submit written documentation of three years experience, on a continuous basis, with successfully heat straightening comparable steel structures.

Before beginning work, obtain the Engineer's approval for details of heat straightening types and methods. Notify the Engineer at least 48 hours before beginning the heat straightening work. Ensure final straightened members retain as little residual stress as possible.

If an area is exposed to precipitation, do not perform heat straightening unless the area is housed as approved by the Engineer. Apply heat at a temperature no greater than 1,200 °F and monitor with contact thermometers, pyrometric sticks, or other heat indicating devices approved by the Engineer. Supply heat indicating devices and make available to the inspector. Provide torch tips with a diameter from ¾ inch

to 1 inch. Heat all plastic yield zones and only plastic yield zones. Use line, strip, spot, and "V", triangular, heats. Do not use a "V" angle greater than 20 degrees. Limit the base of the "V" heat to 6 inches. Heat the "V" from the apex, in a serpentine pattern to the base so only the area directly under the torch shows color. Do not force cool. After each heat straightening cycle, allow steel to cool to below 250 °F before beginning the next heating cycle.

Straighten with as little mechanical force as possible. Use constraints that do not resist contraction during the cooling phase and that do not produce local buckling of compression elements during the heating phase.

Eliminate bends, creases, folds, and dents in web plates, flange plates, angles, stiffeners, channels, gusset plates, and torn areas.

Straighten the flange plates and angles to within ¼ inch of the tilt rotation at the edges from the web, with ½ inch of sweep over 20 feet, ¾ inch at the point of impact. Straighten the web to less than ½ inch out of plumb. Reduce localized deflections in the web to no greater than ½ inch, vertically and horizontally, measured with a straight edge.

Straighten webs to the required tolerances before attaching cross frames or other lateral restraint devices. Do not force beams and girders into position and attach to cross frames to hold in position.

Do not flame cut existing structural steel, except as shown on the plans.

Grind burrs, nicks, gouges, and scrapes to 125 micro-inches per inch rms and taper to the original surface using a 1:10 slope. Provide surface quality in accordance with ASTM A 6.

Report cracks or tears in beams and girders, or in other structural steel members not shown on the plans to the Engineer. The Engineer will direct the repair methods.

Inspect completed straightening for cracks in welds, web, flanges, plates, and connections. Repair cracks by welding in accordance with subsection 707.03.D.8. Provide adequate notice to allow the Engineer to witness the crack repair work. Inspect and test completed straightening and repaired cracks in accordance with subsection 707.03.D.8.c. Perform inspection and testing at no additional cost to the Department.

H. **Rocker Realignment.** Realign tilted rockers as shown on the plans and specified in this subsection. Coordinate the rocker realignment sequencing with proposed bridge repairs as shown on the plans and approved by the Engineer.

If realigning rockers of more than one girder at a time, do not work on the same ends of adjacent girders.

Do not jack existing girder ends more than ⅛ inch above final rocker position.

Before removing rockers from girders, support girder ends on stable shims without using hydraulics.

Grind existing sole plate welds; do not flame cut or air arc gouge existing welds except as shown on the plans and approved by the Engineer.

Before welding sole plates in final position, clean and prime coat faying surfaces and other contact surfaces. Clean and coat faying surfaces and other contact surfaces in accordance with section 715.

Position sole plates with rockers to provide the correct rocker tilt using rocker tilt tables shown on the plans and approved by the Engineer.

Field weld existing sole plates to girder flanges in accordance with subsection 707.03.D.8. Inspect and test field welds in accordance with subsection 707.03.D.8.c.

I. **Cutting Simple Span Beam Ends.** Coordinate sequencing of beam end cutting with proposed bridge repairs, as shown on the plans and approved by the Engineer.

At each location, use a plasma cutting torch to cut no greater than ½ inch off each beam end to provide vertical beam ends 1 inch apart. Use a straight edge or guide to provide horizontal and vertical control during cutting of beam flanges and webs. Mark cut lines on existing beams to verify cutting operations do not damage existing sole plates and bearing stiffener welds.

Do not damage or remove welds on sole plates or bearing stiffeners. Replace damaged welds. Field weld in accordance with subsection 707.03.D.8 and inspect and test in accordance with subsection 707.03.D.8.c.

Grind burrs, nicks, gouges, and scrapes to 125 micro-inches per inch rms on cut edges.

After cutting beam ends and completing field welding, clean and prime coat exposed areas in accordance with section 715.

J. **Structural Steel Welded Repair.** Erect structural steel components in accordance with subsection 707.03.D. Remove damaged or deteriorated structural components and replace with proposed structural components as shown on the plans and specified in section 204.

The Contractor may remove structural steel using mechanical methods, plasma cutting, or air-arc gouging.

Do not flame cut existing structural steel except as shown on the plans.

Prepare existing structural steel to accept proposed structural components and for field welding. Preparation may include field drilling coping holes and grinding, as shown on the plans.

Field weld in accordance with subsection 707.03.D.8. Inspect and test field welds in accordance with subsection 707.03.D.8.c.

After welding structural steel in place, blast clean and prime coat exposed areas in accordance with section 715.

The Contractor may perform cleaning and coating immediately after erection of structural steel components, or during cleaning and coating of the remainder of the girder.

713.04. Measurement and Payment.

Pay Item	Pay Unit
Structural Steel, Furn and Fab, Pin and Hanger	Pound
Hanger Assembly, Field Measurement	Each
Hanger Assembly, Rem and Erect	Each
Heat Straightening Steel (Structure No.)	Lump Sum
Stiffeners, Furn, Fab, and Erect	Pound
Structural Steel, Retrofit, Furn, Fab, and Erect	Pound
Support, Column, Temp	Each
Support, Suspension, Temp	Each
Support, Diaphragm, Temp	Each
Beam Plate, Seal Perimeter	Foot
Rocker, Realign	Each
Cutting Beam Ends, Simple Span	Each
Structural Steel, Welded Repair, Furn, Fab, and Erect	Pound

A. **Hanger Assembly.** The unit price for **Hanger Assembly, Field Measurement** includes the cost of taking and recording measurements, maintaining traffic during measuring, and providing the Engineer with a location drawing showing the span and girder end where measurements were taken.

The unit price for **Hanger Assembly, Rem and Erect** includes the cost of the following:

1. Removing two pins, two link plates, and shear locks;
2. Blast cleaning and applying and curing coating in joint areas;
3. Installing two new link plates and two new pins;

4. Protecting completed joint areas with enclosures, if required; and
5. Protecting newly painted areas adjacent to joint areas.

The unit price for **Structural Steel, Furn and Fab, Pin and Hanger** includes the cost of structural steel required for pins and plates in rehabilitation work. The Engineer will measure steel as specified in subsection 707.04 for structural steel, furnish and fabricate pay items.

The Engineer will measure, and the Department will pay for structural steel required for pins and plates in new construction as specified in subsection 707.04 for structural steel, furnish and fabricate pay items.

The Engineer will measure, and the Department will pay for **Bushing** as specified in subsection 707.04.

B. **Heat Straightening Steel.** The unit price for **Heat Straightening Steel** includes the cost of attaining the required structural steel position, field welding, and nondestructive testing in accordance with subsection 707.03.D.8. The Department will pay for crack repair not shown on the plans as extra work.

C. **Stiffeners, Furnish, Fabricate, and Erect.** The unit price for **Stiffeners, Furn, Fab, and Erect** includes the cost of field drilling, installing bearing stiffeners on existing steel, and blast cleaning and prime coating contact surfaces.

The Engineer will measure structural steel for stiffeners as specified in subsection 707.04 for structural steel, furnish and fabricate pay items.

D. **Structural Steel, Retrofit, Furnish, Fabricate, and Erect.** The unit price for **Structural Steel, Retrofit, Furn, Fab, and Erect** includes the cost of field drilling, installing new structural steel on existing steel, and blast cleaning and prime coating faying and other contact surfaces.

The Engineer will measure structural steel required for retrofit as specified in subsection 707.04 for structural steel, furnish and fabricate pay items.

E. **Support, Temporary.** The unit price for **Support, Temp**, of the type required, includes the cost of providing, placing, maintaining, and removing materials and equipment, and concrete removal and replacement to access temporary supports. The quantity of **Support, Temp**, of the type required, indicates the number of girder ends requiring support; not the number of temporary support devices required.

F. **Rocker, Realignment.** The unit price for **Rocker, Realign** includes the cost of removing existing welds, determining correct rocker tilt, field welding, inspecting and performing nondestructive testing in accordance

with subsection 707.03.D.8, and blast cleaning and prime coating faying and other contact surfaces.

G. **Cutting Beam Ends, Simple Span.** The unit price for **Cutting Beam Ends, Simple Span** includes the cost of cutting existing beam ends, field welding, and performing nondestructive testing in accordance with subsection 707.03.D.8, blast cleaning and prime coating exposed steel, and completing the work for cutting two simple span beam ends at one location.

H. **Structural Steel, Welded Repair, Furnish, Fabricate, and Erect.** The unit price for **Structural Steel, Welded Repair, Furn, Fab, and Erect** includes the cost of removing, disposing, and replacing damaged or deteriorated structural steel components as shown on the plans, field drilling, field welding, nondestructive testing in accordance with subsection 707.03.D.8, and blast cleaning and prime coating structural steel components.

The Engineer will measure structural steel required for welded repair as specified in subsection 707.04 for structural steel, furnish and fabricate pay items.