

Section 713. BRIDGE REHABILITATION - STEEL

713.01 Description. This work includes repairing and replacing structural steel portions of bridges. The term "redundant structure" is defined as a structure whose remaining supporting elements will provide an alternate stress path should one element fail or be taken out of service. In contrast, the loss of any supporting element of a "nonredundant" structure will result in failure of the complete structure.

713.02 Materials. Materials shall meet the following requirements.

Concrete, Grade S2	701
Steel Reinforcement, Grade 400	905
Structural Steel	906
High Strength Bolts, Galvanized A 325	906
Structural Timber and Lumber	912

- A. **Steel for Temporary Supports.** The temporary hanger rods shall meet the requirements of ASTM A 193 Grade B7 (AISI 4140). Longitudinal Charpy V-notch impact values for the rods shall meet an average of 50 foot pounds at 30 °F. In order to meet the Charpy V-notch impact requirements, the steel may need to be heat treated. Notches, nicks, or welds on the rods will be cause for rejection. The Contractor shall furnish to the Department a 15-inch long sample, saw cut from each bar length to be supplied for hanger rod fabrication. These samples are for tensile strength, yield strength, and impact testing. The sample length furnished may be reduced to 8 inches (for impact testing only) if the supplier can provide a Certified Mill Test Report traceable to the material. Each bar sample and corresponding remainder shall be match marked for identification by stenciling in the end cross-section. A Department representative shall witness the removal of the test sample from each bar length to be supplied. Acceptance of the rod material will be based only on Departmental testing and traceable Certified Mill Test Reports.

Heavy hex nuts for the temporary hanger rods shall meet ASTM A 563 Class 10S, and washers shall meet ASTM F 436.

All other steel used for the temporary supports shall meet ASTM A 36 and section 906.

- B. **Sealant for Perimeter of Beam Plates.** The sealant shall be selected from the Qualified Products List. It shall be supplied in caulking tubes.

713.03 Construction.

- A. **Furnishing and Fabricating Structural Steel.** Furnishing and fabricating structural steel additions and replacements for existing structures and for steel portions of temporary supports shall be according to section 707. Shop drawings shall be submitted for approval prior to fabrication.

The center-to-center-of-pins dimension of the replacement link plates shall be built to the measured existing dimensions if they differ by more than $\pm\frac{1}{8}$ inch from the plan dimensions. Other plan dimensions for replacement may be changed to accommodate the existing dimensions as directed by the Engineer.

The fabricator shall submit a final report on the pin and hanger assemblies that lists the as-built dimensions of the new link plates and pins. This report shall clearly show that the tolerances of subsection 707.03.C.11 have been met. Bushings shall be installed according to subsection 707.03.C.12. Pin and link plate pairs shall either be assembled and shipped as a unit or match marked to insure the proper matching in the field.

- B. **Temporary Supports for Girder Ends.** Temporary supports for girder ends may either be as shown on the plans or an alternate design proposed by the Contractor and approved by the Engineer. The alternate design shall be based on loads and allowable soil pressures noted on the plans; the calculations used to arrive at the alternate design shall be included in the submittal. Any alternate design for the temporary support system shall maintain the redundancy and material safety factors specified in the AASHTO *Standard Specifications for Highway Bridges*. The alternate design shall be sealed by a professional Engineer licensed in the State of Michigan.

If the Contractor elects to use a temporary support that is already fabricated, the Department reserves the right to verify the structural adequacy of the entire system. This verification may include, but is not limited to, visual inspection and nondestructive testing by Department personnel. This may require the Contractor to furnish to the Department mill certification of the material used and shop drawings of the original fabrication. If the Department determines that the temporary support is not structurally adequate, the Contractor shall make the required corrections, as deemed necessary by the Department, prior to using the temporary support.

Hydraulic jacks shall have a minimum stroke of 3 inches. The hydraulic system shall be equipped with a dial gage that enables determination of the external load. The hydraulic pump shall be capable of extending the jacks their full stroke.

Hydraulic jacks shall have locking rings or some other positive locking device to prevent settlement in case of hydraulic failure. The locking devices shall be used during and after the jack load changes until stable shims are in place and all loads have been removed from the jacks.

The maintenance of the temporary support shall include replacement in case of partial or complete failure. The Department reserves the right, in case of delay or inadequate progress in making repairs and replacement, to furnish labor, materials, and supervision of work to restore the movement of traffic. The cost of such work by the Department will be assessed against the Contractor.

1. **Column-Type Supports.** After erection and prior to loading of the temporary support, the horizontal offset of the top of the column from the bottom of the column shall be determined by the use of a plumb line. The horizontal offset of the hydraulic jack from the column centerline shall also be determined. Column and hydraulic jack offsets shall be measured in the directions parallel and perpendicular to the column web. At each temporary support the individual offsets and the sum, in each measured direction, of the column and jack offsets shall not exceed one inch. Jack offsets are considered positive regardless of the direction of the column offsets.

Where Structure Embankment (CIP) is not called for, natural ground shall be compacted, to a depth of 9 inches, to not less than 95 percent of its maximum unit weight before the temporary supports are placed.

When the temporary support is placed on a paved shoulder or roadway the leveling course shall be 21AA aggregate, asphaltic cold-patch material, or other material approved by the Engineer. The material used for leveling shall be compacted to 95 percent of its maximum unit weight before the temporary supports are placed.

Bracing of the temporary supports, as directed by the Engineer, may be required depending on the method selected by the Contractor for performing the rehabilitation work.

The jacks shall remain in place until the link plates and pins are installed and fully operational. The lines and pump may be disconnected, but they shall be kept available at the job site.

The Contractor shall check for settlement of the temporary support hourly during the first four hours after loading. Subsequent settlement checks shall be made daily. Corrective action shall be taken by the Contractor, by adding shims to the temporary support, to prevent the girder end from subsiding more than $1/16$ inch from its original position.

2. **Suspension-Type Supports.** After stable shims are in place, the jacks may be removed with the approval of the Engineer.

All concrete removed for erecting the temporary support or for access to the girder end shall be repaired, as approved by the Engineer.

C. Pin and Hanger Replacement.

1. **Measurement of Existing Hanger Assemblies.** The Contractor shall take field measurements of all hanger assemblies to be replaced and submit these as-built dimensions in the existing structure, along with a drawing showing the span and girder end where the measurements were taken, to the Engineer.

The measurements required on the existing hanger assemblies include the pin diameter, the center-to-center distance between pins (measured on each side) in each assembly, and the length, width, and thickness of the link plates.

Girder web alignment shall be checked by laying a straight edge across the pin plate gap at both the top and bottom of the girder. Any girder offset shall be measured and reported.

Any lane or shoulder closure required to permit the field measurements of the hanger assemblies to be taken shall conform to the *Michigan Manual of Uniform Traffic Control Devices* and the project documents, and shall be approved by the Engineer. The

Contractor shall not leave a lane or shoulder closed overnight when such lane or shoulder closure is required to take the field measurements.

2. **Removal of Existing Hanger Assemblies.** Removal methods shall be according to subsection 204.03.A.5, this subsection, and the plans.

If the Contractor elects to remove and replace the link plates and pins of more than one girder at a time, work shall not be done on the same end of any adjacent girder. The suspender at the opposite end of a girder where the link plates or pins are to be removed shall be completely assembled and operational.

The two pins and two link plates shall be removed in each assembly. No component shall be removed until the girder end is completely supported without the use of hydraulics, on stable shims and all loads have been removed from the hydraulic jacks. When it is necessary to flame cut the link plates and pins for removal, the following procedures shall be followed.

- a. The link plates may be flame cut in two pieces by making a sloping transverse cut that coincides with the joint opening between the girder ends. If the link plates are cut at the pin, a sheet metal heat shield shall be positioned behind the link plate to protect the end of the girder from the cutting process.
 - b. The pins may be flame cut for removal after a metal heat shield is placed around the pin hole so that the pin plate is protected from the cutting process. The pin ends may be trimmed to within one inch minimum of the girder pin plate. A hole may be burned through the center of the pin to facilitate removal. If the hole in the girder pin plate is gouged by this removal, it shall be ground smooth to remove the gouge before blast cleaning and coating. No welding repair of the girder pin plate hole will be permitted except when authorized in writing by the Engineer.
3. **Installation and Coating of New Hanger Assemblies.** When the end diaphragms prevent the installation of the new pin (may occur on sharply skewed bridges at the top pin), an oblong hole may be flame cut in the web of one of the end diaphragms using a minimum $\frac{1}{8}$ inch thick steel hole template, clamped to the channel section, as a cutting guide. After flame cutting, the hole edges shall be ground smooth to remove any gouges or irregularities to a maximum surface roughness of 125 microinches per inch rms. This hole shall be cleaned and coated and left in the finished structure. At no time shall the end diaphragm be loosened or removed.

After the pins have been removed, all notches and deep pits that exist in the girder pin plate around the periphery of the hole shall be ground smooth to a maximum surface roughness of 125 microinches per inch rms. The girder ends, within 3 feet each side of the centerline of the pin holes or to the nearest stiffener, shall then be cleaned and coated according to section 715, before the new hanger assembly is installed.

The new hanger assembly shall be fully assembled before the falsework shims are removed.

- D. **Bearing Stiffeners at Temporary Supports.** Erecting bearing stiffeners at temporary supports shall be according to section 707. These stiffeners shall be left in place as a permanent part of the structure. The bolt holes in the existing girder shall be field drilled; flame cutting or air arc gouging of the existing girder or proposed attachments will not be permitted. All field drilling shall be completed prior to blast cleaning and prime coating of the faying surfaces.

Prior to erecting the bearing stiffeners, the faying surfaces and all other contact surfaces shall be cleaned and coated. (Faying surfaces are defined as all surfaces internal to a connection that bear on an adjacent surface.) Cleaning and coating shall be done according to section 715.

After the bearing stiffeners have been bolted in place, the exposed areas shall be cleaned and coated according to section 715. This cleaning and coating may be done immediately after erection or when the remainder of the girder is cleaned and coated.

- E. **Retrofit Structural Steel.** Erecting retrofit structural steel shall be according to subsection 707.03.D. This structural steel shall be left in place as a permanent part of the structure. The bolt holes in the existing steel shall be field drilled; flame cutting or air arc gouging of the existing steel or proposed attachments will not be permitted. All field drilling shall be completed prior to blast cleaning and prime coating of the faying surfaces.

Prior to erecting the structural steel, the faying surfaces and all other contact surfaces shall be cleaned and coated. Cleaning and coating shall be done according to section 715.

After the structural steel has been bolted in place, the exposed areas shall be cleaned and coated according to section 715. This cleaning and coating may be done immediately after erection or when the remainder of the girder is cleaned and coated.

- F. **Sealing the Perimeter of Beam Plates.** The sealant shall be applied around the perimeter of bolted or riveted plates or angle on a steel beam as directed by the Engineer. Apply the sealant over the intermediate coat when dry to the touch. The top coat shall be applied over the sealant when the intermediate coat is fully cured. The surfaces between the repair plate or angle and the beam and the surfaces in contact with the sealant shall be clean and dry at the time of application. The sealant shall not be applied when the air or surface temperature is below 40 °F. Immediately after the sealant is applied, it shall be tooled to form a $\frac{5}{16}$ inch fillet and to force it against the contact surface. Sufficient sealant shall be applied to completely fill all pits and depressions regardless of width and depth in the steel beam at the seam line.

- G. **Heat Straightening Damaged Structural Steel.** This work shall be performed under the direct on-site supervision of a specialized person who shall present written documentation of successful heat straightening experiences with comparable steel structures. The documentation shall show that this person has been actively heat straightening bridge structural steel on a continuous basis for the past three (3) years.

Prior to beginning work the Contractor shall propose, for the Engineer's approval, complete details of the type and method of heat straightening to be used. The Engineer shall be

notified at least 48 hours prior to starting the heat straightening work. The heat straightening shall be done in such a manner that the final straightened member retains as little residual stress as possible. Heat straightening shall not be performed when the area to be straightened is exposed to periods of precipitation unless the area to be heat straightened is housed in a manner approved by the Engineer. Heat shall be applied at or below 1200 °F and monitored with contact thermometers, pyrometric sticks, or other heat indicating devices as approved by the Engineer. These heat indicating devices shall be supplied by the Contractor and made available to the inspector at all times. Torch tip sizes shall be ¾ to 1 inch diameter. All plastic yield zones and only plastic yield zones shall be heated. The heat straightening shall be accomplished with the use of line, strip, spot, and "Vee" (triangular) heats. The "Vee" angle shall not exceed 20 degrees. The base of the "Vee" heat shall not exceed 6 inches. The "Vee" is heated from the apex, in a serpentine pattern, to the base in a manner such that the only place showing color is directly under the torch. Forced cooling is not permitted. After each heat straightening cycle the steel shall be allowed to cool to below 250 °F before commencing the next heating cycle.

The straightening shall be accomplished with as little mechanical force as possible. Constraints shall not resist contraction during the cooling phase and shall not produce local buckling of the compression element during the heating phase.

All bends, creases, folds, and dents of the web plates, flange plates, angles, stiffeners, channels, gusset plates, and torn areas shall be eliminated.

Final straightness tolerances for the flange plates and angles shall be within ¼ inch of tilt rotation at the edges from the web and ½ inch of sweep in 20 feet (¾ inch at the point of impact). The final web shall be less than ½ inch out of plumb. Localized deflections in the web shall be no more than ½ inch as measured with a straight edge held vertically and horizontally. These tolerances shall be met before any cross frames or other lateral restraint devices are attached. In no case shall the beams/girders be forced into position and then attached to the cross frames to hold them in position.

No flame cutting of any existing structural steel will be allowed except as noted on the plans.

Burrs, nicks, gouges, scrapes, etc. shall be ground to a surface finish of 125 microinches per inch rms and tapered to the original surface using a 1 on 10 slope to eliminate possible stress concentrations. Surface quality shall comply with ASTM A6.

Any cracks or tears found in the beam/girder or other structural steel members not shown on the plans shall be reported to the Engineer. Recommendations will be given for proper repair methods.

The completed straightening shall be inspected for cracks in the welds, web, flanges, plates and connections. This inspection shall be according to subsection 707.03.D.8.c. The contractor is responsible for this testing and it shall be witnessed by the Engineer. Cracks shall be repaired by welding according to subsection 707.03.D.8.

713.04 Measurement and Payment.

Contract Item (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, (<u>Structure Number</u>)	Lump Sum
Stiffeners, Furn, Fab, and Erect	Pound
Structural Steel, Retrofit, Furn, Fab, and Erect	Pound
Support, Column, Temp	Each
Support, Suspension, Temp	Each
Beam Plate, Seal Perimeter	Foot

A. Hanger Assembly.

1. **Hanger Assembly, Field Measurement** includes payment for taking and recording the measurements, maintaining traffic while the measurements are being taken, and providing the Engineer with a location drawing showing the span and girder end where the measurements were taken.
2. **Hanger Assembly, Remove and Erect** includes payment for removing two pins, two link plates, and shear locks, for blast cleaning and applying and curing the coating in the joint area, for installing the new link plates and pins, for protecting the completed joint area by enclosure, and for protecting the newly painted area adjacent to the joint area. No payment will be made for **Hanger Assembly, Remove and Erect** until the final top coat has been applied.
3. Structural steel required for pins and plates in new construction will be measured and paid for as specified in subsection 707.04 for structural steel, furnish and fabricate.
4. Bushings will be measured and paid for as specified in subsection 707.04.

B. **Heat Straightening Steel** includes payment for the necessary materials, labor and equipment to attain the desired position of the structural steel as described herein. Payment also includes field welding and nondestructive testing according to subsection 707.03.D.8.

C. **Stiffeners, Furn, Fab, and Erect** includes field drilling, installing bearing stiffeners on existing steel and blast cleaning and prime coating all contact surfaces.

D. **Structural Steel, Retrofit, Furn, Fab, and Erect** includes field drilling, installing new structural steel on existing steel and blast cleaning and prime coating faying and all other contact surfaces.

E. **Support, Temp**, of the type specified, includes payment for furnishing, placing, maintaining, and removing the necessary materials and equipment described. The quantity for **Support, Temp**, of the type specified, indicates the number of girder ends to be supported and not

necessarily the number of temporary support devices required. A sufficient number of support devices shall be furnished and used to fulfill the requirements shown on the plans and to ensure completion of the project within the contract time.

All concrete removal and replacement necessary for access for temporary supports shall be included in **Support, Temp.**