SECTION 564 - STRUCTURAL STEEL

Description
Under this section of the Specification, the contractor shall follow the requirements of Section 106-01, Source of Supply and Quality Requirements. Materials provided for the project have to be sampled and tested by groups within the Department. It is critical to the project that these notifications occur early in the project time line. The State must have Quality Assurance oversight of the fabrication and approved welding procedures must be in place prior to the commencement of work.

Materials
Subsection 715-01 establishes the requirements for inspection and acceptance of steel plate and rolled shapes. The responsible person in the field should make certain that the material specified in the contract documents and approved shop drawings is that which is accepted at the site. The specification may call out steel with improved toughness requirements when the material is in tension or is used in a fracture critical application. These provisions should be clearly indicated in mill test reports (see Exhibit 564-C & D) submitted for acceptance.

Basis of Payment
Original shop drawings that are approved and distributed become the property of the State after project completion and must be submitted to the Deputy Chief Engineer Structures (DCES) prior to final payment. This is under the provisions of Section 202.8 of the New York State Steel Construction Manual (SCM).

Partial Payment
Under provisions of Section 100, the Contractor is eligible for partial payment for the percent of completed steel that is delivered but not erected. The Contractor requests the payment through the EIC. Upon confirming through the DCES that the steel has been fabricated in accordance with the SCM, partial payment can be issued for the stored steel.

Additional Work
Field Fabrication

Field Verification
In the case of rehabilitations, field measurements are critical to the proper reassembly or refabrication of the bridge superstructure. Often contractors will try to use “As Built” Drawings or existing Shop Drawings in lieu of field survey. This method assumes that no field modifications occurred during the original construction contract. Also, the plans may not consider remedial maintenance work that may have occurred on an interim basis. If the reconstruction notes direct the contractor to perform a field survey, this function should not be waived. This is especially true of riveted structures where the connections and splice patterns may be irregular or not meet current (SCM) guidelines for edge distance and center to center spacings.

Field Drilling
This operation may be done by either using a twist drill or a core drill. The core drill is usually preferred because of the speed of operation. The drill will have a magnetic base and use a press type arm to apply pressure while drilling through the steel. This allows the operator to make cylindrical holes free from burrs. Chapter 10 of the SCM controls tolerances for out of round and percentage of non uniform holes in any pattern.

Field Tolerances
Many of the shop and field dimensional tolerances for steel fabricated bridge components are listed in Chapter 12 of the SCM. These tolerances dictate the fabrication methods and controls that are in place in Chapter 11 under Assembly. These are most difficult to control when the fabrication is connecting main members such as an extension to a steel cap beam or extending floor beams. The methods allowed are full size drilling from the solid or drilling subsized holes and reaming to full size.
Field Welding

General
Department personnel involved in field welding of structural steel (new or existing) shall ensure that the Contractor is in compliance with all applicable provisions of the Standard Specifications, the New York State Steel Construction Manual (SCM), and any special contract provisions.

Subsection 564-3, Structural Steel, Construction Details of the Standard Specification, states: “... all structural steel work, including, but not limited to fabrication, inspection, transportation, and erection shall be done in accordance with the provisions of the SCM.” This establishes the SCM as part of the Contract and is applicable to both shop and field work.

The Construction Supervisor, Engineer-In-Charge, or Resident Engineer, as applicable, shall verify that the Contractor has designated a Quality Control (QC) Inspector to act on the contractor’s behalf as required under Subsection 302 of the SCM.

Under Subsection 306 of the SCM, the Contractor is responsible for performing fabrication/erection inspection and testing to ensure that materials and workmanship meet the requirements of the Contract Documents. The Contractor’s QC Inspector may be supported in this task by Assistant Inspectors who may perform specific inspection functions under his/her supervision. Assistant Inspectors may be qualified by training and experience to perform the specific function(s) to which they are assigned.

As NYSDOT projects are typically shop welded and field bolted, field welding of structural steel is unusual. Field welding typically encompasses pile foundation work, bridge bearings, form work and the like. However, the requirements for structural steel set an example of good practice for all field welding.

Approvals

Welding Procedure Specification (WPS)
Subsection 704, General, of the SCM, states: “... all welding shall be performed in accordance with the provisions of a written Procedure Specification, as shown in Figure 704.” The completed Form (Figure 704) is referred to as a Welding Procedure Specification (WPS). The contractor must complete a separate WPS for each Welding Process (e.g., Shielded Metal Arc Welding, SMAW) and joint type shown on the Shop Drawings, or shown on the Plans, and submit them to the Structures Division, Metals Engineering Unit, for approval. No welding shall be allowed without an approved WPS. For reference, a sample WPS is attached (See Exhibit 564-A). WPS’s are not transferable from project-to-project, unless a written waiver is provided by the Metals Engineering Unit.

Welding Processes - Procedure Qualification
Subsection 705, Approved Welding processes of the SCM, states: “... all welding processes, except Shielded Metal Arc Welding (SMAW), must be qualified by tests performed by the Contractor as required by Section 8, Qualification.”

In general, SMAW (stick welding) is the only process approved for field welding. Exceptions to this may be considered for certain applications (e.g., cover plates, ballast plate) in which case Submerged Arc Welding (SAW), or Flux-Cored Arc Welding (FCAW) may be approved. For either exception, a Procedure Qualification Test (Section 8, SCM) is required. Procedure Qualification Tests require the Contractor to weld a test plate with the process and welding parameters proposed to be used in production. Various specimens machined from the test plate are then tested by the Department. These tests need to be approved by the Metals Engineering Unit prior to processing WPS's.
SMAW (stick welding) is prequalified (Subsection 705, SCM) if the steel and electrodes are listed in Subsection 502 and Subsection 711.1 of the SCM, respectively. When these provisions are met, the Contractor may submit WPS’s for approval without performing a Procedure Qualification Test.

Welder Qualification

Subsection 809, General of the SCM states: “... each welder, welding operator, and tacker who performs work on Contracts for the State must be qualified for each process and position used by tests described in this Section.” (Welders not currently NYS Qualified may obtain testing program information by contacting the Metals Engineering Unit).

Qualified SMAW (stick) Field Welders are issued a NYS Qualification Certificate and Work Record Card which must accompany the certificate for it to be valid. The certification card carries a validating signature, the welder’s signature, positions qualified, and in the case of groove welds, the maximum thickness of steel the welder is qualified to weld. For the certificate to remain valid, the Work Record must be signed every six months from date of issuance by either a Region EIC or a Licensed P.E. (Any State). For reference, see Subsection 811.9b.

Prior to allowing a welder to work, the EIC, or Department Representative, must verify that the welder is qualified to weld in the position (Flat, Horizontal, Vertical, Overhead), thickness (groove welds only), and process indicated on the approved WPS’s. Position limitations are defined in Table 811.3 of the SCM.

NOTE: A welder reporting for work whose Work Record has minimally lapsed, but who otherwise is acceptable, may be granted a waiver of the six-month limit if the EIC requests a waiver from the Metals Engineering Unit. (This is an accommodation in recognition of the shortened construction season in the Northeast. The EIC should check his work quality more closely when he begins work.)

Workmanship and Technique

General

The provisions of Section 7, Part B of the SCM, cover the essential parameters for producing quality welds by low hydrogen practice. Many of these provisions are directly controlled and implemented by welding in accordance with the approved Welding Procedure Specification (WPS). Each entry on the WPS must be verified and/or monitored during any field welding operation.

Special Concerns

Below are special concerns related to producing sound welds in the field.

1. Subsection 711.1, Electrodes for Manual Shielded Metal Arc Welding (SMAW) requires that Electrodes be furnished in hermetically sealed containers and shall be dried in an Electrode Oven for a 2 to 4-hour period between 232°C and 260°C before use. After drying, the electrodes shall be placed in a storage oven held continuously at a temperature of at least 121°C until used in the work.

2. E70XX and E80XX Electrodes, once removed from the storage oven, shall be used within 2 hours and 1 hour, respectively, or discarded. If the humidity is known to be less than 70%, the time may be doubled.

   Electrodes may be redried once in lieu of discarding, if, and only if, the provisions of Subsection 711.1 are met. This requires an oven capable of reaching temperatures of 371°C to 426°C, which is not commonly available at the job site.

3. A Minimum Preheat and Interpass Temperature shall be maintained during all field welding. The
actual temperature to be used shall be in accordance with the approved WPS. Subsection 708.1 of the SCM specifies the minimum preheat/interpass temperature of 121°C for field welding. Higher temperatures can be anticipated for certain combinations of material and thickness.

Exceptions to the stated minimum preheat/interpass temperature are made when welding studs or when welding sole plates of non-steel type bearings where the temperature of the bearing material cannot exceed 93°C.

4. When field welding of FCM’s is required, welding shall be in accordance with Section 9 - Fracture Control Plan of the SCM. Implementation of the Fracture Control Plan shall be under the direction of the DCES, Metals Engineering Unit. All WPS’s used for welding FCM’s shall be so designated. No welding shall be allowed without the WPS so marked, regardless of approval. Field welding of FCM’s is rare, particularly on new construction.

Weld Quality Inspection Obligations

Contractor

Under Section 3 of the SCM, the Contractor is responsible for the acceptability of the product through Quality Control (QC) inspection and, when required by the Contract Documents, nondestructive testing. In general, the Contractor’s QC Inspector and Assistant Inspectors are required to make all necessary inspections to ensure weld quality is in compliance with the Contract Documents.

Under Subsection 724 of the SCM, Visual and other Non-Destructive inspection methods for determining weld quality and acceptance are described in detail.

“Visual inspection of welding shall be performed before, during, and after completion of the welding” as stated under Subsection 724-1 of the SCM. Non-Destructive Inspection of welds by means other than visual (i.e., DT, MT, UT, or RT) shall comply with Subsection 724.2 of the SCM when specified on the approved shop drawings, repair drawings, or ordered by the DCES/Metals Engineering Unit.

State (Department or Resident)

1. General. Under Section 3 of the SCM, is the prerogative of the State. The State may waive independent QA inspection or perform this function with Department representatives as deemed appropriate.

Normally, the waiving of QA inspection is not an option for metal elements with welded connections. However, it is considered acceptable for most field welding applications to perform QA inspection on a limited task-specific basis; i.e., verifying Contractor’s compliance with key functions of workmanship and technique that are essential to producing sound welds. (See QA Inspection Punch List for specific tasks.)

Department QA personnel need not be certified (i.e., AWS Certified Welding Inspector, CWI) unless required by the DCES, for a project-specific field welding operation. The Construction Supervisor, Engineer-In-Charge, or Resident Engineer, as applicable, shall verify that the Department’s QA Inspector(s) are qualified to perform the specific functions to which they are being assigned.

The Structures Division, Metals Engineering Unit will provide technical support to Region Staff involved in steel inspections and is available to provide training and on-site inspection support when necessary. Technical support may be arranged by contacting the Metals Engineering Unit at (518) 457-4525.

NOTE: QA inspection of field-welded Fracture Critical Members shall be under the direction of the DCES (Metals Engineering Unit).
SECTION 564 - STRUCTURAL STEEL

2. QA Inspection Activities - Field. QA inspection is not intended to supplement or replace inspection that is the responsibility of the Contractor, but rather to monitor that the Contractor’s QC program has been implemented and is producing results consistent with the Contract Documents. The QA Inspector’s schedule shall effectively determine that the Contractor’s QC in-process inspection and testing, where applicable, are insuring compliance with all material and workmanship provisions of the SCM. Any deficiencies in material or workmanship should be immediately reported to the Metals Engineering Unit for evaluation. Acceptance of structural steel welding in the field by the QA Inspector shall be based upon monitoring the Contractor’s QC program as implemented and selective detailed inspection of materials and workmanship.

3. QA Inspection Punch List. Listed below are key activities which may be used as a quick reference by Department personnel involved in QA inspection of welding in the field.

A) If welding structural steel (564 items), contractor’s QC Program has qualified and adequate staff.

B) Received from the Contractor: WPS’s approved by the DCES (Metals Engineering Unit) for each joint type and position to be welded.

NOTE: Valid WPS must display Project’s “D” Number.

C) Welders are NYS certified with current Work Record, and qualified for the process and position shown on the approved WPS.

D) Welding parameters shown on the approved WPS are being used, preheat monitored, and stick electrodes properly dried.

E) Visual inspection of welds. Include review of certified mill test reports (CMTRs), fitup, edge preparation and weld access holes or backing bars (welded pile splices) as appropriate prior to welding. During welding make sure slag is removed between passes, welding progression is per WPS (stringer beads, vertical up, etc.) and welds are free of cracks and porosity. After welding is complete, make sure slag is removed, weld profile is acceptable per SCM Figure 723, and free of defects per SCM Section 724. Pay particular attention to undercut/overlap, under fill and insufficient throat. Welds should be free of cracks and rejectable porosity.

F) Written report received from NYS qualified non-destructive testing (NDT) Technician documenting the results of weld joint testing, where required. Rejected welds repaired by a procedure approved by the Metals Engineering Unit.

G) Welding of fracture critical members must be approved by the DCES and directed by the Metals Engineering Unit.

Repairs
Field Repairs, Corrections of Cambers or Heat Straightening shall be done in accordance with the NYS Steel Construction Manual. The work shall be done following a repair procedure prepared by the contractor and approved by the DCES. No repair work involving heating, jacking or welding shall be allowed without an approved repair procedure.

Erection of Steel
The guidelines for erection of structural steel are in the Steel Construction Manual under Section 14. Close coordination is critical between field personnel and the approver. The site layout should match...
the plan view shown of the approved erection drawing as the reviewer may not be familiar with the site.

The erection procedure drawing should be submitted for review 30 days prior to the scheduled day of lifting.

Maintenance and protection of traffic should be approved by the appropriate project staff member so that normal roadway traffic is maintained in accordance with the notes on the contract plans.

Safety and Health requirements are addressed in Section 107-05 of the Standard Specifications and MURK Part 1C.

Site Storage and Handling

Girder Delivery
The girders should be delivered and stored with webs vertical unless a special delivery procedure was approved by the DCES.

The minimum support that a standing girder requires is two supports at the points one-fifth of the span from the ends. Occasionally, because of stability concerns the supports can be required at intervals as small as tenth points along its length.

During temporary crane shutdowns, the Girder should be lowered and released so that no damage is done to the flanges.

Transportation Drawing
As specified in Section 206.1, transportation drawings may be required for girders that are unusual in terms of temporary stress conditions. Examples are curved girders with overhangs greater than 7.5 meters, girders that must be shipped with webs horizontal or those that could buckle unless stabilized. These drawings should be submitted to the DCES for approval.

Inspector’s Responsibility
The duties of the shop inspector are summarized in the Steel Construction Manual in Chapter 3. The inspector shall be responsible for Quality Assurance that ensures the bridge components meet all the standards and specifications required for its manufacture.

Shipping
B&GC4b - Report of Shipment of Structural Steel
This form documents that the fabrication was in accordance with contract requirements. The EIC can expect to receive the above form from the inspection agency about the same time as the material test reports (MTR). The materials test reports contain the mechanical properties, chemical analysis and the certification of domesticity. For contract items where the engineer is the approver for the State, the MTR’s will be delivered directly for him to issue the B&GC4b. (See Exhibit 564-B).

References
NEW YORK STATE STEEL CONSTRUCTION MANUAL
NYSDOT BRIDGE MANUAL
NYSDOT STANDARD SPECIFICATIONS
MURK PART 1C