STRUCTURAL FABRICATION QUALITY MANUAL

August 2023 Edition

In accordance with the 2020 Standard Specifications for Construction

MDOT
Michigan Department of Transportation

STRUCTURAL FABRICATION UNIT
BUREAU OF BRIDGES AND STRUCTURES

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1 General Information

The purpose of the Structural Fabrication Quality Manual (SFQM) is to provide the Michigan Department of Transportation (MDOT) Structural Fabrication Unit (SFU) with information for the implementation of MDOT's quality assurance (QA) program for fabricated materials required to be accepted based on "Fabrication Inspection" per the Material Acceptance Requirements Table located in MDOT's Materials Quality Assurance Procedures (MQAP) manual. The SFQM is instrumental to ensuring consistency in performing QA fabrication inspection at nationwide and international fabrication plants by providing general information, fabrication inspection procedures, inspection and test plans (ITP), supplier qualification standard, and approved supplier list (ASL). It is important to note that MDOT's SFU utilizes consultants to provide fabrication inspection and project management while the SFU provides fabrication engineering and program management. Finally, only sections of this document referenced in the MQAP manual are contractual to the Contractor; however, this document is required to be followed by the SFU and their consultants when implementing MDOT's QA program for structural fabrication inspection.

Local Agency Program (LAP) projects are not required to follow this manual in its entirety. The MDOT Materials Quality Assurance Procedures (MQAP) manual is contractual by direct reference in the MDOT Standard Specifications for Construction and references select sections of the SFQM in the Materials Acceptance Requirements Table. Only the select references (i.e., Section 2 – Fabrication Inspection Procedures and Section 5 – Approved Supplier List) are required to be followed by the local agency with other sections for informational purposes only.

1.1 Definitions

Below is a list of terms that are significant to this manual:

1.1.1 Consultant

An agency providing services to a client. In Sections 1 through 5 of this SFQM, the term "Consultant" is used to identify the agency performing fabrication inspection and project management services to the SFU.

1.1.2 Contractor

The Contractor is responsible for proper completion of all tasks required by the contract. Subcontractors, including fabricators, erectors, and field painters, may be used by the Contractor, but the Contractor retains responsibility for all material, operations, and the final product. The Contractor should permit direct subcontractor interaction with MDOT to expedite the project, but subcontractors must inform the Contractor of any proposed modifications to contract requirements.

1.1.3 Design Project Manager (PM)

The Design PM can be the Engineer of Record or could be managing a consultant contract where the consultant is the Engineer of Record.

1.1.4 Engineer

The Engineer can be the Director of the Department of Transportation or the MDOT Construction Engineer designated by the Director, acting directly or through authorized representatives, who is responsible for engineering supervision of the construction. The Engineer has the authority to allow exceptions to contract document requirements.

1.1.5 Engineer of Record (EOR)

Those preparing the contract documents, including those responsible for the structure's adequate design. The Engineer of Record seals and signs the contract plans.

1.1.6 Fabrication Inspection

The examination by MDOT or the Fabricator of processes and products to verify general conformance with contract requirements.

1.1.7 Fabrication Inspection Acceptance

The first step in MDOT's two-part acceptance process for structural products required to be accepted based on "Fabrication Inspection" per MDOT's MQAP Manual.

1.1.8 Fabricator

The facility performing such shop activities as cutting, welding, drilling, punching, tying rebar, tensioning strand, pouring concrete, cleaning, and coating of structural steel, etc. The Fabricator also includes any agents of the Fabricator, such as those who prepare shop detail drawings, perform nondestructive examinations, coatings, etc.

1.1.9 Field Inspection Acceptance

The second step in MDOT's two-part acceptance process for structural products required to be accepted based on "Fabrication Inspection" per MDOT's MQAP Manual.

1.1.10 Materials Quality Assurance Procedures Manual (MQAP)

The formal written document prepared by MDOT that describes the policies and procedures used to accept materials for incorporation into MDOT projects.

1.1.11 Materials Source Guide (MSG)

The formal written document prepared by MDOT go give information and guidance to personnel associated with sampling, testing, and inspection of materials used in MDOT and federal aid secondary projects. Portions of the MSG are contractual by way of reference in other contract documents.

1.1.12 Michigan Department of Transportation (MDOT)

The entity (owner) paying the Contractor to fulfill the terms of the contract. MDOT also encompasses the Engineer who is authorized and responsible for engineering supervision of the construction. The Engineer is an employee of MDOT; however, MDOT may contract with a professional firm to oversee the day-to-day supervision with all critical decisions coming through the Engineer.

1.1.13 Nonconformance Report (NCR)

An alteration in the work or a fabrication error that results in the element not meeting project specifications. The Fabricator generates an NCR submittal after fabrication has begun and their QCI has noted a nonconformance to the project specifications.

Nonconformances are generally defined to be material or workmanship in nature and are further classified by MDOT to be minor or major.

Minor nonconformances can be repaired by the Fabricator without approval of an NCR, whereas major nonconformances require approval of an NCR.

1.1.14 Precast Concrete

Precast concrete is a construction product produced by casting concrete in a reusable form, which is then cured in a somewhat controlled environment, transported to the construction site, and lifted into place. Precast concrete can be either prestressed or non-prestressed. In contrast, cast-in-place (CIP) concrete is poured into site-specific forms and cured on site.

1.1.15 Procedure Qualification Record (PQR)

A production welding procedure specification qualification is based on a procedure qualification test record (PQR) produced by the Contractor in conformance with required heat input qualifications and other code requirements. The test is designed to provide assurance that the weld metal produced by welding in conformance with the provisions of the code must produce weld metal strength, ductility, and toughness conforming to the code.

1.1.16 Quality Assurance (QA)

Quality assurance (QA) encompasses the activities undertaken by the Owner to verify that the final product satisfies contract requirements, including verifying that quality control is performed effectively.

1.1.17 Quality Assurance Inspector (QAI)

MDOT's representative that is responsible for duties specified herein, with the authority to accept work that meets contract requirements.

1.1.18 Quality Control (QC)

The activities undertaken by the Contractor/Fabricator to ensure a product meets contract requirements.

1.1.19 Quality Control Inspector (QCI)

A qualified employee of the Fabricator who performs inspection as defined by the Fabricator's Quality Control Plan.

1.1.20 Quality Control Plan (QCP)

The QCP is a document developed by the Fabricator describing, in detail, all aspects of production and fabrication for the project to ensure consistent control of quality to meet specification requirements.

The Quality System Manual (QSM) or Quality Manual prepared by the Fabricator and reviewed by a certification body (ACPA, AISC, NPCA, PCI, etc.) may satisfy the requirements of a QCP.

These documents may not include enough detail to function as a QCP for MDOT projects. Fabricators may need to supplement their manuals with separate plans and procedures that address MDOT project-specific requirements. This approach limits the need for rewriting and resubmitting their manuals for certifying body approval.

1.1.21 Request for Information (RFI)

Requests by the Fabricator seeking additional information or proposing alternate material, fabrication method, or inspection method for the structural element.

1.1.22 Spot Inspection

The random examination of the Fabricator's processes or products for verification of conformance with contract requirements.

1.1.23 Standard Specifications for Construction (SSC)

The SSC is the standard for the basic requirements governing the materials, equipment, and methods used in construction contracts administered by MDOT.

1.1.24 Structural Fabrication Unit (SFU)

MDOT's specialized construction unit that is responsible for implementing the MDOT's QA program for fabricated materials required to be accepted based on "Fabrication Inspection" per MDOT's MQAP. The SFU utilizes consultants to perform fabrication inspection and project management.

1.1.25 Supplier

The firm (fabricator, manufacturer, galvanizer, producer, etc.) selected by the Contractor and approved when required by MDOT to provide products and services to MDOT for a specific project.

1.1.26 Welding Procedure Specification (WPS)

A formal written document specifying a welding procedure, which provides direction to the welder or welding operators for making sound and quality production welds in accordance with the American Welding Society (AWS) code requirements. The WPS is supported by a PQR or is based on a prequalified joint and results in repeatable and trusted welding techniques.

1.2 Contact Information

For all instances where this document states for the QAI to notify, carbon copy, or contact the SFU, the communication must be directed to the Consultant's PM for consultant inspected and managed projects. The Consultant's PM will in return notify, carbon copy, or contact the SFU as required. Please see the SFU contact information below:

- Concrete Inspection: MDOT Structural Precast Concrete Specialist
- Steel Inspection: MDOT Structural Steel Specialist
- Engineering: MDOT Structural Fabrication Engineer
- Contract: MDOT Structural Fabrication Engineer

1.3 Responsibilities

Below are expectations for a team effort and responsibilities to improve success.

Team Effort

The Contractor is ultimately responsible for furnishing a product that meets the contract; however, MDOT will approach QA as a team effort with the Fabricator's QC to facilitate accurate and timely construction. It is important to note QAI's inspection and testing is based on the following criteria:

- Sampling approach at suitable intervals that may be modified or waived based on other priorities and finite inspection hours.
- Inspection and testing are performed after QC has completed their inspection and the product is found acceptable at that point of the fabrication.
- Inspection and testing are performed to optimize efficiency of QAIs time and reduce or eliminate idling the Fabricator's work.

All parties will cooperate and maintain open lines of communication so that problems can be quickly addressed and resolved.

QAI's verification does not relieve the Fabricator from the responsibility to perform the required testing and inspection and produce a product satisfying the contract.

1.3.1 Fabricator

A. Provide quality control to ensure that the finished product meets or exceeds contract requirements.

B. Develop and implement a QCP that reflects a commitment to quality and describes the quality control activities that will be employed on each project.

C. Provide MDOT with a copy of the QCP.

D. Submit shop drawings to MDOT for review with WPS and supporting PQR, as applicable.

E. Provide a Material Source List (MSL) for structural precast (prestressed and non-prestressed) concrete projects prior to the prefabrication meeting.

F. Provide qualified QCIs who report to personnel responsible for quality control as defined by the QCP.

G. Provide MDOT with an accurate notification before beginning work in the shop and all production scheduling as required by the contract requirements.

H. Present all material for the QAI 's acceptance in a manner that will allow a thorough inspection of components and assemblies.

I. Provide the QAI full access to shop facilities where the work is being stored, fabricated, or assembled.

J. Provide the QAI with all approved shop drawings, NCRs, RFIs, MDOT Welder Qualification test reports, WPSs, QC reports, material certifications/test reports, non-destructive examination/non-destructive test (NDE/NDT) reports, personnel/plant certifications, equipment calibration reports, and all other applicable documents in a timely manner as required by the contract requirements.

K. Keep the QAI informed prior to performing in-process repairs, NCRs (if applicable), QC inspection activities, and pending NDE/NDT (if applicable).

1.3.2 MDOT

The items below which identify MDOT as the subject are included to clarify MDOT policies affecting quality assurance. All other items are responsibilities of both MDOT and the QAI.

A. Monitor the Fabricator's control of the operations and verify conformity of the work with the contract requirements.

B. Keep the Fabricator's QCP confidential.

C. Observe fabrication (either on a schedule or at random) and perform testing of materials and fabricated products as necessary to confirm the effectiveness of the Fabricator's QCP.

D. MDOT, either directly or through the QAI, has the right to observe all phases of the work, from initial receipt and preparation of raw materials through prestressing, tying steel, fresh concrete testing, placing concrete, testing cylinders, repairs, burning and cutting, welding, nondestructive testing, cleaning, coating, shipping, and any other activities deemed appropriate by MDOT.

E. The frequency and nature of QA inspection will vary with the type of structure, experience of the Fabricator, strength of the Fabricator's QC organization, and other similar factors that affect the quality of work.

F. Verify that production quality and fabrication processes generally satisfy contract requirements, including the QCP.

G. Accept materials and fabricated products that satisfy the contract requirements.

H. Notify MDOT when Fabricator ships products for projects and specify if the shipment is the final shipment for the project.

I. Submit project file to MDOT within one week of final shipment of products.

J. MDOT will not waive items that are contractual obligations of the Fabricator and will not accept material that does not conform to the contract requirements. However, based on experience and knowledge of the specific situation, the Engineer may accept materials and products that are not in conformance with the contract and may allow material substitutions and/or alternate fabrication methods. See the following documents for more information:

   - *MDOT Structural Fabrication Nonconformance Policy*
   - *MDOT Structural Fabrication RFI Process*

K. Avoid directing the Fabricator's work but advise the Fabricator to discontinue any operation that would result in noncompliance with the contract.

L. Direct all official communications to the Fabricator's quality control or management as determined in the prefabrication meeting.

M. Avoid conveying directives or personal judgements about overall shop quality or concerns about employee competence to production personnel.

N. Neither MDOT nor the Consultant will publish, copy, or distribute any proprietary information, documents, or forms received from the Fabricator for any purpose other than the contractual needs of MDOT.

1.3.3 Prefabrication Meetings

Prefabrication meetings facilitate effective quality control and quality assurance and are conducted by the SFU prior to the start of fabrication and preferably after shop drawings have been approved. The SFU, QAI, Fabricator, and QCI must be present, whereas the Engineer and Contractor should be present to ensure a team effort to facilitate accurate and timely construction. Quality assurance and quality control contact information will be shared during this meeting to ensure effective and timely communication.

1.4 QAI Roles and Responsibilities

1.4.1 Qualifications of the QAI

Qualification requirements of the QAI is covered in Section 2 of this manual for the required fabrication inspection procedure.

1.4.2 Equipment Requirements of the QAI

Equipment requirements of the QAI is covered in in Section 2 of this manual for the required fabrication inspection procedure.

1.4.3 Scheduling

The scheduling of inspection and other QA functions can have a significant impact on the project. The QAI must follow these guidelines:

A. Coordinate with the QCI for anticipated production scheduling to anticipate timing and staffing needs. Discuss the progress of the work with appropriate fabrication personnel designated during the prefabrication meeting.

B. Schedule inspections in a timely manner to facilitate fabrication progress, especially if multiple shifts are used.
C. Discuss with the SFU whether additional presence in the shop is required.
D. Document problems with scheduling inspection, including inaccurate information from fabrication personnel and production delays.

1.4.4 Role of the QAI

A. Monitor, witness, and perform activities to verify what is observed conforms to the contract requirements. Although the QAI does not perform the QC work, some QA activities may duplicate a portion of the QC activity for verification purposes.
B. If there are questions about a requirement or level of quality, contact the SFU and, if appropriate, alert the Fabricator.
C. Conduct consistent inspections based on the fabrication inspection procedure and ITP and obtain assistance from the SFU as needed.
D. Be familiar with the QCP to better understand the QC operations of the shop.

1.4.5 Responsibilities of the QAI

The QAI is generally responsible for executing MDOT's responsibilities which are listed above in subsection 1.3.2. Product specific responsibilities are further detailed in the Fabrication Inspection Procedures below.

1.4.6 Interaction with the Fabricator QCI

A. Verify the effectiveness of the QCI's evaluation of the work.
B. Perform verification inspection after the QCI has completed their inspection and testing in accordance with the Fabricator's QCP. However, serious problems noted at any time or stage of fabrication must be immediately pointed out to the QCI.
C. Though QA inspection may include all aspects of fabrication, the QAI must not supersede QC, which is the responsibility of the Fabricator. If QC is not accomplishing its role, then the SFU, Engineer, Contractor, and Fabricator must determine the necessary corrections.

1.4.7 Interaction with Fabricator

If the Fabricator's inquiries involve design questions, material substitutions, alternate fabrication methods, or items that are beyond the authority of the QAI, please refer them to *MDOT's Structural Fabrication Request for Information Process*. If the Fabricator's inquiries involve fabrication or material nonconformance questions, please refer them to *MDOT's Structural Fabrication Nonconformance Reporting Process*. Do not direct the Fabricator.

1.4.8 Interpretation of the Contract

Review contract requirements and seek guidance from the Consultant's PM if there are questions. Do not direct the Fabricator.

1.4.9 Fabrication Observation

A. Establish a pattern of regular and frequent observations during the progress of work to verify satisfactory workmanship without delaying production or missing critical operations.
B. Coordinate verifications with the QCI and accomplish them with minimal additional material handling by the Fabricator and with as little interference with the work in process as possible.
C. Though there are not designated points during fabrication when the suitability of materials must be checked, problems should be discovered and addressed as early as possible.

D. Provide narrative records in accordance with subsection 1.5 of this manual.

1.4.10 Nonconforming Materials and Workmanship

See the following documents for information on material and workmanship nonconformances:

A. MDOT Structural Fabrication Nonconformance Policy
B. MDOT Structural Fabrication Nonconformance Reporting Process

1.4.11 Final Acceptance of the Work

Acceptance of structural products must be in accordance with Section 2 of this manual and the ITP specified in the MDOT work assignment (WA).

1.5 Narrative Report Writing

The purpose of this subsection is to provide the QAI with guidance on preparation of the narrative report that is submitted to the SFU. This guidance will be used to ensure consistent presentation of the required information and format. While the examples are focused on steel and concrete fabrication, this guidance applies to all materials and products requiring fabrication inspection as the basis of inspection.

This subsection is broken down as follows:

1. Expectations for Consistency and Quality of Reports
2. Narrative Reporting Basics
3. Types of Information
4. Acceptable Report Forms
5. Recommended Best Practices

1.5.1 Expectations for Consistency and Quality of Reports

MDOT expects its QAIs to strive for consistent and high standard of reporting, both from a single inspector and across all QAIs. This can be achieved in part by adhering to general writing requirements and making accurate and detailed accounts of observations.

1.5.2 Narrative Reporting Basics

Narrative reports require discipline and skill. Good habits and time management are necessary QAI practices to ensure observations are captured while the details are fresh. Obscure writing styles can lead to misinterpretation of information. Unbiased and emotionless writing is essential for the level of professionalism expected by MDOT. “We” should be avoided in narrative report writing if more than one QAI is working on an assignment over the period covered by the report; however, it may be acceptable provided it is defined in the report who “we” includes.

1.5.2.1 Frequency

The narrative report is a weekly documented summary of the daily activities that the QAI has witnessed being conducted by the Fabricator or has performed as part of their assigned duties. Complete the report as close to the end of shift as possible while events are still fresh in the QAI’s mind.

1.5.2.2 Style

When preparing the narrative report, be clear and concise. Use complete sentences to describe the observations and tasks performed. Extended or detailed explanations are discouraged unless

there is a need to convey additional information that may not be recorded on other MDOT reporting forms.

Spell out the first-time use of abbreviations or acronyms not already defined in contract documents or industry standards. Avoid using industry slang.

Use of tables, lists, or other presentation methods is encouraged.

Use space between sections and new paragraphs for each process or activity. Use underlining or bold fonts or other positive means of starting new days.

Insert photographs when applicable for supporting descriptions of quality issues or nonconformity. Make sure photographs are date/time stamped and labeled for easy reference.

1.5.2.3 Perspective

Eliminate any bias or insensitivity. Emotion or personal feelings of the QAI regarding the observations encountered in the fabrication shop is inappropriate. Treat the narrative report as a permanent professional record that may be read by many different audiences.

1.5.3 Types of Information

Although MDOT does not expect an inordinate amount of time spent on report writing, narrative reports must be accurate and provide a thorough report of observations. The QAI's account must include fabrication progress, QAI observations, overall project status, and important discussions.

1.5.3.1 Fabrication Progress

Provide a discussion of the progress of fabrication observed in the shop over the reporting period. Address all the aspects of the work occurring in the shop. Keep the discussion brief in nature. Indicate whether the work was observed by the QAI in progress or was completed without QAI presence. The entries in the narrative report may be made daily if the progression of work is very rapid and changing daily. Alternatively, a weekly summary of work may be made if the progression of work is relatively slow for larger and complex projects.

1.5.3.2 QAI Observations

Record the QAI observations made to determine Fabricator compliance to established written procedures and contract specifications. Examples of these observations include verifying the welding machine set-up matches the established weld procedure or observing aggregates for signs of contamination, segregation, or gradation concerns; note the QAI's direct measurements when performing verification testing or inspection. Include issues with ineffective QC performance. Clearly indicate which procedures and contract specification requirements were verified and the day(s) that the compliance was observed.

1.5.3.3 Project Status

Document the status of the project. Indicate the estimated percent complete. A best guess of the percentage complete is appropriate especially when the project complexity obscures the determination; percentage can be based on number of pieces or weight or another reasonable characteristic.

1.5.3.4 Important Discussions

Document important discussions held during the week in the Narrative Report. Important discussions include schedule and inspection coordination, project team communications, interaction with QC on complex issues such as nonconformance resolution or notification of observed deficiencies. Information required for each discussion includes:

1. Purpose of the discussion
2. Date and time the discussion
3. Type of discussion (face-to-face, telephone, video, etc.)
4. Duration
5. Attendees
6. Outcomes of the discussion (decisions made, recommendations provided, action items assigned, etc.)

1.5.4 Acceptable Report Forms

MDOT will accept narrative reports on either its *Fabrication Inspection Report* (Form 5617) or the Consultant's preferred form, provided they adhere to standard content requirements.

1.5.4.1 MDOT Form

MDOT Form 5617 is provided as a fillable Portable Document Format (PDF) file for use by the QAI.

1.5.4.2 Consultant Forms – Specific Required Fields

The QAI may choose to use their own form using a platform that best suits their needs. The minimum following fields must be included in the Consultant's form:

1. Inspection Agency
2. Inspector Name
3. Date/Week Ending
4. Job Number
5. MDOT ID
6. Job Description
7. Report Number
8. Material Fabricated (in-process)
9. Section for Daily Narrative/Comments
10. Fabrication Progress (% complete)
11. Visual Inspection (VI)
12. Material Acceptance

1.5.4.3 Specific Information Required – Both Forms

Narrative reports, whether written on MDOT or Consultant forms, are written by the QAI for several types of products supplied to MDOT. These products categories are described earlier. Supplemental to the minimum required fields explained above and the general report contents discussed below, MDOT also expects inclusion of information specific to each type of material (concrete or steel); this supplemental information is detailed in Appendix 2 and 3 below.

Narrative sections of any report must include the following general contents:

✓ **Brief Narrative of Work Performed:**

Briefly highlight the work performed by the QAI for each day they were present at the Fabricator and actively working on MDOT projects.

✓ **Weather Conditions:**

It is important to document the weather conditions that were experienced for the given day. Temperature (high and low), precipitation, wind conditions and relative humidity can play a significant role in the outcomes of a fabricated product. Precipitation, wind conditions and relative humidity is not required to be documented for indoor work when not applicable to work activity. Although some Fabricators conduct their operations inside of protected buildings, record outside weather conditions every day. Include the average conditions and extreme changes such as wind, rain, or snow events. Indicate the exposure level of the work (i.e. – completely controlled enclosure, partially enclosed without control, completely exposed to weather).

✓ **Elements Worked on by the Fabricator:**

Identify what piece marks or elements were worked on during the reporting period.

✓ **Materials Incorporated into the Elements:**

Provide a list of materials that are being incorporated into the elements being produced. This may be documented in the narrative report or may be referred to in a specific report that is generated by the QAI. For precast concrete elements, including this list on *MDOT Form 5617* is enough.

✓ **Work Activities:**

Document the work activities that were conducted by the fabricator. Include a current schedule of upcoming work each week and note major changes or deviations by the fabricator.

✓ **Requests for QA Inspection and Satisfaction of Hold Points:**

Record requests for QA inspection from the fabricator, notification from the fabricator of reaching hold points, and any hold points that were satisfied or waived. Include details unless the means of communication was written; otherwise reference the written communication by type (email, letter, etc.), sender, and date/time.

✓ **Nonconformances:**

Document nonconformances issued by the QAI in the narrative report. If a nonconformance report has been generated by the fabricator, note this in the report as well as the nature of the nonconformance. Reference the Nonconformance Report number when documenting the resolutions to the nonconformance including witnessing of the repairs and re-inspections. Include the notification to QC.

✓ **Shipping:**

Provide the status of the shipping of elements as the information becomes available. This would include indicating that pieces have been inspected, reported on the appropriate MDOT form, and stamped for shipping, the bill of lading has been reviewed and stamped, and scheduled dates for shipping current stamped piece marks/elements and future piece marks/elements.

✓ **Hours Worked:**

Document the hours worked during the reporting week. Report hours to the required accuracy, typically in half-hour increments. These hours include:

1. Total hours at the shop for this project (floor plus reporting)
2. Hours on the shop floor for this project
3. Hours worked on report and form preparation for this project

4. Travel time allotted to this project (split evenly between multiple projects and reported on other weekly reports)

✓ **Force Account Work:**

There may be rare occasions where the Fabricator may be supplying product under a force account. Document the dates and elements that were worked on in the narrative report as force account work and verify documentation required for the MDOT *Force Account – Daily Field Record* (Form 1101A) is referenced in the report.

✓ **Other Information the QAI Deems Important:**

Report information that is deemed important to the production, inspection, delivery, and schedule of the project. Note any concerning practices or controls.

1.5.5 Recommended Best Practices for Reporting

These additional guidelines explain MDOT's expectations for professional reports based on observed best practices among its consultants and report sampling from other agencies outside MDOT.

✓ **Referencing External Records/Reports:**

Provide direct references to other required MDOT forms or supporting QA reports/records. This includes tying specific processes conducted by the QAI or the Fabricator to the required MDOT form/record. For example, if the QAI witnessed a certain procedure that required reporting on a specific form, the QAI would note the observation and refer to the specific form for the results/observations. A list of completed forms by report number for that day is also acceptable.

✓ **Identifying Verified Materials:**

Document material verification and acceptance per batch, lot, heat, item, brand, supplier, etc. when provided in the narrative report. Ensure that the recorded information is easily understood. In certain circumstances, it may be suitable to report the material in a tabular format.

✓ **Reporting Coordinated QC Activity:**

Clearly identify QAI performance of QC activities or process. This may be an activity that is conducted in conjunction with the QC or a standalone activity.

✓ **Reporting Untimely Notification:**

Provide feedback on QC performance by the Fabricator. Note the QC department's involvement in providing timely notification to the QAI regarding inspection hold points. Identify QC process steps that were omitted, or not addressed in an appropriate manner.

✓ **Avoid Running Lists:**

Refrain from restating specification, material, or procedure compliance from earlier days or weeks. Avoid copying and pasting data or information, such as tables or lists, from previous days. Only report the activities observed or performed that day. Keep a running list separately for progress tracking, making it available to MDOT upon request.

✓ **Report Your Own Observations:**

Never report the observations or comments of other inspectors. Properly qualified temporary replacement or substitute inspectors may assist an assigned shop inspector. The assigned inspector may not report the activities on behalf of the performing inspector. Avoid more than one inspector's name on a single report; each inspector must prepare an independent report, regardless of the crossover of activities.

1.6 Fabrication Inspection Flowchart

See Appendix A1 for the *MDOT Structural Fabrication Inspection Flowchart*.

1.7 Web Links

This subsection contains several important links to resources related to structural fabrication inspection for MDOT. To access, click on the title of each bullet for the link.

- Standard Specifications for Construction

This link will take you to a printable/downloadable copy of the applicable version of the SSC, as well as the Supplemental Specifications (errata) and Frequently Used Special Provisions (FUSP). There are subsections that are related specifically to structural precast concrete and structural steel inspection.

- Materials Quality Assurance Procedures Manual

This document provides guidance on MDOT's requirements for material acceptance and other quality assurance procedures.

- Materials Source Guide

This document describes the acceptance criteria for materials and should be looked at prior to the materials being incorporated into a project.

- MDOT Buy America Compliance Listing

This site contains a listing of Approved Manufacturers, Qualified Products List (QPL) and Tested Stock Suppliers that are either fully compliant, partially compliant, or do not have any steel/iron in their product as noted next to each company name. For our use we only need to look at the Buy America (BA) BA+ or BA- listings.

- MDOT Metals Lab Sampling & Testing Guidance Document

This document contains the *Metals Laboratory Sampling Guide* (see bookmarks) that provides the procedures for sampling all materials required to be tested by MDOT's Metals Laboratory.

- MDOT Welder Qualification Program

This document discusses MDOT's welder endorsement program that is used to verify a welder's ability to meet AWS qualification requirements for welding parameters (process, position, thickness, etc.) that they request to be tested for.

- Bureau of Bridges and Structures – Structure Construction Section

This site serves as a statewide resource for structures and contains contact reference materials and contact information for MDOT bridge personnel.

- Structural Fabrication Unit

This site contains contact information, reference documents, SFQM, standard ITPs, and ASL.

- MDOT Forms

All inspection forms are stored on this site which can be searched by the form number or title.

1.8 Inspection File Closeout

The purpose of this subsection is to provide the SFU with a process for structural fabrication inspection file closeout. MDOT requires all fabrication inspection records provided by the contractor to be in PDF and for the construction files to be stored in ProjectWise.

1.8.1 Receiving Fabricator Documents

Fabricator must provide SFU with electronic PDF files. Documents are provided to SFU's QAI as required by the contract for their review prior to stamping elements approved for use.

1.8.2 Creating Quality Assurance Documents

QAI must convert all QA documents into PDF files. Fillable PDF forms typically require "flattening" to embed form fields, comments, and any other type of annotation into the page content prior to combining the PDF files to prevent the fields in similar forms from merging. Stamped hardcopies of the Bill of Lading must be scanned by the QAI (if not stamping electronically) for inclusion in the final documentation package. The paper copy can be discarded after scanning.

1.8.3 Assembling and Bookmarking Fabrication Inspection File

QAI combines, arranges, and bookmarks all project QA and QC documents in one PDF fabrication inspection file. See the MDOT *Fabrication Inspection Checklist* (Form 1942 for steel and Form 2001 for concrete) for instructions on assembling and bookmarking the fabrication inspection file.

1.8.4 Placing Fabrication Inspection File into ProjectWise

QAI places the final fabrication inspection file into the project's "MDOT In Box" folder located in ProjectWise.

1.9 Frequently Asked Questions

The purpose of this subsection is to provide answers to frequently asked questions to ensure consistency and alignment.

1.9.1 Fabricating without Approved Shop Drawings

The QAI must notify the SFU immediately if the fabricator is not working from shop drawings stamped "Approved" or "Approved Subject to Correction". Note that approved shop drawings will be stamped on each sheet and approved subject to correction shop drawings are typically only stamped on the first page. Shop drawings must be stamped approved (on all sheets) prior to stamping products approved for shipping. The QAI must be given adequate time to review their as-fabricated records with the approved shop drawings prior to shipping.

1.9.2 Inspecting Approved Repair Plans

QAI must have the approved repair plan in hand prior to performing QA verification inspection of the repair. Verification inspection also includes confirming that production and QCI have the approved repair plan. If production and QCI do not have the approved plan, then the QAI must notify them that they are required to have the approved plan in hand during all aspects of the repair. If the Fabricator begins working on the repair without the approved plan, then the QAI must notify the Fabricator of their observation in writing immediately and carbon copy the Consultant PM. The Consultant PM will discuss with the SFU to determine if the repair will be approved or rejected.

1.9.3 Stamping Pieces Approved for Use

QAI must have approved shop drawings prior to stamping any pieces approved for use. Pieces proposed to be shipped by the Fabricator that are not in general conformance with the approved shop drawings must not be stamped. The only exception is if an NCR has been approved by MDOT. Approved NCRs are to be used in conjunction with approved shop drawings for acceptance. If product is not in conformance with the approved shop drawings, then it must not to be stamped approved for use by the QAI. Approved RFIs must be incorporated into the shop drawings, if applicable, prior to shipping.

1.9.4 Welder Qualification Testing

MDOT requires the Fabricator to submit the *MDOT Welder Qualification Test Request* (Form 0571) for SFU approval prior to the start of welder qualification in the shop. The purpose of the request form is to verify the fabricator's proposed welding personnel and qualification plan is reasonable for the project and to verify the welder's that will be tested already meet AWS qualification requirements.

See *MDOT's Welder Qualification Program* for all welding information.

1.9.5 As-Built Shop Drawings

The Fabricator is required to submit as-built shop drawings to MDOT for historical purposes. All approved RFIs that are incorporated into the project must be reflected in the shop drawings and submitted to MDOT for review and approval. Very minor changes toward the end of fabrication must be documented and submitted as as-built shop drawings to the QAI prior to shipping. NCRs are not required to be incorporated into shop drawings. The SFU can provide more guidance on a project-by-project basis as to what constitutes a shop drawing revision and what is considered an as-built.

An acceptable method for creating an as-built shop drawing is to use a computer program (Adobe, Kofax, AutoCadd, Microstation, etc.) to mark-up all applicable changes in the approved shop drawings. The changes are required to be clouded/bubbled without covering up details or notes on the approved shop drawing. A note stating who (company name, title of individual making the changes) and date of the changes must be included in a separate note. The entire complete set (all sheets that have been marked up and all other unmarked approved sheets) of shop drawings is required to be submitted as an as built shop drawing.

1.9.6 Fabrication Inspection File Records

MDOT requires all fabrication inspection records to be provided by the contractor in PDF files except the records noted below. The QAI must convert all QA records into PDF files and "flatten" fillable PDF forms to embed form fields, comments, and any other annotation into the page content prior to combining the PDF files to prevent the fields in similar forms from merging. Stamped hardcopies of the Bill of Lading must be scanned by the QAI for inclusion in the fabrication inspection file. Radiographic film is the only other record that is currently received as a hardcopy.

2 Fabrication Inspection Procedures

The fabrication inspection procedures included in this section form the minimum requirements that are expected to be performed. There are many factors that go into determining the appropriate level of fabrication inspection for a particular project that must be decided by the Engineer. The following factors, at a minimum, should be considered:

1. Product type
2. Complexity
3. Open or closed fabrication (open construction may offer an opportunity to inspect at a later date)
4. Fabricator experience
5. Fabricator performance and/or effectiveness of their quality management system (QMS)
6. Project schedule

The ITPs referenced in the SFQM provide additional guidance and expectations for the QAI; however, the Engineer must still determine how much quality assurance is acceptable for each project. Similar to MDOT, the local agency must determine an appropriate level of inspection needed for their project based on factors that they deem important to the success of their project.

2.1 Non-Prestressed Structural Precast Concrete Fabrication

2.1.1 Scope

This non-prestressed structural precast concrete fabrication inspection procedure should be used to aid the QAI in interpreting and enforcing the contract for non-prestressed concrete products. Fabrication inspection includes the time from verifying materials used for fabrication through loading for shipping to the construction site. The following non-prestressed structural precast concrete products are inspected using this procedure:

1. Bridge main members
2. Bridge secondary members
3. Culverts
4. Prefabricated bridge element systems
5. Mechanically stabilized earth panels
6. Noise barrier wall posts and panels
7. Other products specified in the contract or directed by Engineer

2.1.2 Reference Documents

A. QAI must have a thorough knowledge of the following references:

1. MDOT Structural Fabrication Quality Manual (michigan.gov)
2. Materials Quality Assurance Procedures (MQAP) (michigan.gov)
3. MDOT Materials Source Guide

4. Applicable sections of the MDOT 2020 Standard Specifications for Construction [WEB]-linked (michigan.gov) as modified by Supplemental Specification for Errata to the 2020 Standard Specifications

MTM 108	Michigan Test Method for Materials Finer than No. 75 Sieve in Mineral Aggregates by Washing
MTM 109	Michigan Test Method for Sieve Analysis of Fine, Dense Graded, Open Graded, and Coarse Aggregates in the Field
MTM 110	Michigan Test Method for Determining Deleterious and Objectionable Particles in Aggregates
20SP-105A	Source of Steel and Iron (Buy America)
20SP-406A	Revisions to Precast Three-Sided, Arch, and Box Culverts
20SP-706B	Mechanically Stabilized Earth Retaining Wall System
20SP-708A	Quality Control and Acceptance of Structural Precast Concrete

5. Applicable Frequently Used Special Provisions
6. Prefabrication meeting minutes (if applicable)

B. QAI must be familiar with the following references:

1. Michigan Test Methods (MTM)
2. ASTM Standards

C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C94	Standard Specification for Ready-Mixed Concrete
C138	Test Method for Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete
C143	Standard Test Method for Slump of Hydraulic Cement Concrete
C172	Standard Practice for Sampling Freshly Mixed Concrete
C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C1064	Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
C1504	Standard Specification for Manufacture of Precast Reinforced Concrete Three-Sided Structures for Culverts and Storm Drains
C1577	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD
E29	Standard Practice for using Significant Digits in Test Data to Determine Conformance with Specifications

3. Applicable plant certification program standard:

   APCA QCAST Plant Certification Manual

NPCA Quality Control Manual for Precast Concrete Plants

PCI MNL-116 Manual for Quality Control for Plants and Production of Structural Precast Concrete Products

4. Fabricator's QSM and QC procedures
5. MDOT Accident Prevention Plan

2.1.3 Qualifications, Responsibilities, Duties, and Equipment

2.1.3.1 Qualifications of the QAI

QAI performing the fabrication inspection must possess the following qualifications:

1. Michigan Concrete Association (MCA) Level I Field Testing Technician certification or American Concrete Institute (ACI) Concrete Field Testing Technician – Grade I (except period of effectiveness will be reduced from 5 years to 3 years to match MCA); and
2. If aggregate sampling or testing is performed, QAI must possess the necessary Michigan Certified Aggregate Technician (MCAT) Level I, Level II, or ACI Aggregate Testing Technician – Level I certification.

2.1.3.2 Responsibilities of the QAI

QAI performing the fabrication inspection is not permitted to make changes to the contract and has the following responsibilities:

The Contractor, Fabricator, and MDOT will approach quality control and quality assurance as a team effort to facilitate accurate and timely construction. QAI's verification does not relieve the Fabricator from the responsibility to perform the required testing and inspection to produce a product satisfying the contract. Though QA inspection may include all aspects of fabrication, the QAI must not supersede QC, which is the responsibility of the Fabricator. If QC is not accomplishing its role, then the SFU, Engineer, Contractor, and Fabricator must determine the necessary corrections.

QAI is the responsible party, representing the Engineer, who performs quality assurance verification inspection on the element after QC inspects and approves the item of work. The QAI must provide inspection during fabrication as directed by the SFU and must perform each inspection item shown in subsections 2.1.4.3 thru 2.1.4.7 a minimum of once per project or per the project ITP whichever is more frequent. If issues arise, it will be at the Engineer's discretion whether to increase the level of QA inspection.

It is the Engineer's responsibility to engage the EOR when making structural decisions. The Engineer is also responsible for following internal MDOT procedures for review and approval of shop drawings, fabrication procedures, RFIs, NCRs, and for professional decision making on fabrication problems that arise. The Engineer relies on the SFU to manage and assist when appropriate. The Engineer has the prerogative for holding a prefabrication meeting with the Fabricator to discuss and clarify the contract plans and specifications. The Engineer is the responsible party who ensures MDOT's fabrication QA program is followed for inspection and acceptance of the product.

Fabrication should proceed only with approved shop drawings. However, if the Fabricator must proceed prior to receipt of approved shop drawings (performing work at their own risk), ensure that the SFU is aware of this activity and await instruction on how to proceed. If the Engineer permits the work to proceed without approved shop drawings, proceed with basic QA functions using the non-approved shop drawings. Later, verify notes against approved drawings. Notify the SFU immediately if fabrication is not in conformance with the approved shop drawings.

2.1.3.3 Duties of the QAI

QAI performing the fabrication inspection has the following duties:

1. QAI must thoroughly understand the contract.
2. QAI must verify steel material certifications show compliance with BA contract requirements.
3. QAI must be proficient in performing fresh concrete tests, sampling aggregate and other materials, verifying material traceability, and inspecting concrete pours.
4. QAI must be proficient in writing reports and using computers.
5. QAI must notify the SFU if production begins before approved shop drawings are on the shop floor and provided to the QAI.
6. QAI must communicate all concerns through QCI or whomever the Fabricator directs during the prefabrication meeting.
7. QAI must communicate with QCI to obtain the work schedule.

2.1.3.4 Deficiencies on LAP Projects

MDOT's QAI must notify the SFU if they observe fabrication or inspection deficiencies on LAP projects. The Structural Fabrication Engineer will report the deficiencies via email to the Engineer that is responsible for construction oversight of the LAP project and carbon copy the applicable CFS and Design Division LAP Engineers.

2.1.3.5 Inspection Facilities and Access

Facilities for the QAI must be provided by the Fabricator per contract. QAI must always have access to all parts of the work. The authority and general duties of the QAI are specified in subsections 104.01.D and E of the MDOT Standard Specifications for Construction.

2.1.3.6 Inspection Equipment

QAI will be furnished with the following items by the SFU:

1. Contract (SSC, special provisions, standard plans, special details, plan sheets, etc.)
2. Approved shop drawings (provided by Fabricator)
3. MDOT shop approval stamp
4. Numbered plastic sample tags, sampled adhesive tags for material sampling, and numbered metallic MDOT sample tags

QAI must provide the following inspection equipment:

1. Computer with high-speed internet access
2. Cell phone
3. Digital camera (can be integral with cell phone)
4. Flashlight
5. Temperature measuring devices capable of covering from 0°F to 200°F
6. Fresh concrete testing equipment (thermometer, slump cone kit, and air-meter)
7. Measuring devices (20-foot and 200-foot steel tape and calipers)

8. Straightedge and levels
9. Safety equipment
10. Other equipment as needed

2.1.4 Inspection Procedure

2.1.4.1 Prefabrication Meeting

Prefabrication meetings facilitate effective quality control and quality assurance on the project and are conducted by the SFU prior to the start of fabrication and preferably after shop drawings have been approved. The SFU, QAI, Fabricator, and QCI must attend (in person or virtual), whereas the Engineer and Contractor should attend (in person or virtual) to ensure a team effort to facilitate accurate and timely construction. Quality assurance and quality control contact information will be shared during this meeting to ensure effective communication.

2.1.4.2 Inspection Overview

Non-prestressed concrete must be fabricated in accordance with the SSC and contract. Fabrication inspection is performed in accordance with the ITP specified in the MDOT WA.

1. Non-prestressed concrete fabrication inspection consists of verifying compliance with the approved shop drawings, contract, and approved NCRs. RFIs must be incorporated into the approved shop drawings for the QAI to inspect to.
2. An approved MSL, submitted by the Fabricator to the SFU for review and approval, is provided to the QAI so that the QAI knows what materials are being incorporated into the project and what the basis of acceptance is. The MSL is used to initiate conversation about who will perform the QA sampling and testing and foster communication between QA and QC to ensure all required sampling and testing occurs in a timely manner to prevent impacts to the project schedule. It is the Fabricator's responsibility to notify the QAI when materials are available for sampling.
3. QAI begins by inspecting materials that will be used in the fabrication process and verifies they are being stored correctly, tagged for traceability purposes, and are in conformance with the contract. Next, the QAI observes the Fabricator's operations to verify the type and condition of the equipment meet the contract.
4. MDOT's Accident Prevention Plan states, "MDOT employees shall not engage in any act which would endanger another employee or themselves". QAI must notify the SFU immediately if work conditions exist that are not safe. If the level of inspection diminishes below what is specified in this QA procedure, due to safety concerns, then the element will not be approved for use.

2.1.4.3 Forming and Casting

1. General Information

QAI must confirm the dimensional requirements of the bulkheads, side forms, bearing plates, steel reinforcement, void boxes, inserts, and any other devices per the approved shop drawings as part of their post-pour inspection. The only exception is that anything that cannot be inspected post-pour, must be inspected during pre-pour. It is important to emphasize that QA must not supersede QC so the QAI's inspection must come after QC has completed their inspection and approves the element. QAI then uses the QC inspection reports (if available) during their verification inspection.

2. Concrete Forms

Concrete forms must be maintained and remain true to the shapes and dimensions as shown on the approved drawings.

a. Metal forms must be used since they are designed to be rigid for repetitive castings without deforming or weakening due to the heat from the hydration process. Forms must be well braced and stiffened against undesirable deformations under pressure of fresh concrete and must have smooth joints and inside surfaces accessible for adequate cleaning after each use.

b. Joints between panel forms must be made and maintained smooth and tight. Unless otherwise shown on approved shop drawings, all corners or intersections of surfaces exposed in the completed structure must be chamfered with a minimum dimension of 0.50 inches and all re-entrant angles must be rounded with a minimum radius of 0.75 inches.

c. Forms that are warped, distorted, damaged, or improperly cleaned must not be used. Wood forms may be used for bulkheads. The inside faces of all forms must be coated with an approved chemical release agent.

3. Reinforcing Steel

QAI must confirm that the reinforcing steel is of the correct size, free from defects, and properly positioned. The reinforcing steel must be free of oil, lubricants, foreign material, and excessive rust. If epoxy coated bars are to be used, then nicks in the coating are not permitted.

QAI must spot check that the reinforcing steel has been properly positioned and secured in accordance with the approved shop drawings and make certain that inserts have been placed where required.

4. Tests on Fresh Concrete

QAI must perform testing as required in the contract and document the results in *MDOT Form 0590*. The Fabricator must collect additional fresh concrete for QAI to perform their tests as needed.

5. Placing of Concrete

The concrete must be promptly placed with minimum handling to avoid segregation of the materials and the displacement of the reinforcement. Each element must be cast in a continuous operation with minimal interruption between the placing of adjacent portions of concrete and each layer must be placed and consolidated before the preceding layer has taken initial set.

6. Consolidation of Concrete

A minimum amount of vibration necessary to thoroughly consolidate the concrete must be used. QAI must verify a rubber coated vibrator head is used when epoxy-coated or other coated reinforcement is used.

2.1.4.4 Curing Requirements

Curing requirements for non-prestressed concrete must be as specified in the contract. When steam or radiant heat curing is used, recording thermometers must be provided by the Fabricator that monitors the time/temperature relationship through the curing period while artificial heat is used. The QAI must verify that the recording thermometers are placed in critical locations for monitoring the time/temperature relationship during the curing period. Recording thermometers (number based on project requirements) must be placed at locations where the anticipated heat generated by the concrete is the lowest and highest just after initial concrete set. Documentation from the Fabricator's recording thermometer must be given to the QAI for their review. Temperature requirements during the curing operation must be in accordance with the contract specifications.

2.1.4.5 Material Requirements

Materials must meet the requirements of the contract unless an RFI requesting alternate materials has been approved by the Engineer.

2.1.4.6 Shipping Requirements

Products must attain the required compressive strength as indicated by test results of QC compressive strength test cylinders, which have been cast and match cured for this purpose as described per the contract. These cylinders must be cast with numbered metallic MDOT sample tags.

2.1.4.7 Concrete Compression Strength Testing

QAI witnesses concrete strength testing at the sampling frequency of the governing ITP. Watch for specimen ID, handling, machine condition, and QC procedural compliance. Verify proper interpretation and reporting of results by the QCI.

2.1.5 Reports

A. The Engineer may require a periodic status report from the SFU; therefore, all reports are required to be completed in a timely and orderly manner using the applicable forms listed below that can be found on MDOT's website. Make entries as soon as possible after an event or conversation to ensure accuracy. Number the reports consecutively until completion of the work with the last report noted "final".

B. QAI must complete an accurate and detailed account of fabrication for the project. The report must include a discussion of fabrication progress for all aspects of the work. It is intended to be a detailed record of the status of fabrication and should include number of products fabricated, documentation of specification and procedure compliance as well as documentation of conflicts, repairs, and other problems or discussion which could affect the project in any way. If force account work is taking place, document each day that the work occurs in the shop and which products are being worked on.

C. Documentation is not a substitute for appropriate dialogue with the Fabricator but should provide a record of important discussions. In some cases, the QAI is more familiar with the events or issues and therefore should review and comment on draft copies of the SFU's correspondence.

D. Reports must be assembled into one fabrication inspection PDF file and stored in MDOT's ProjectWise document storage program per subsection 1.8 of this document.

E. Below is a list of various MDOT forms and a brief description of their purpose and use requirement. Similar forms can be used in place of the standard MDOT form if noted below. All completed forms or equivalent forms are placed in the fabrication inspection file at the end of the project.

1. *Bar Reinforcement Report (Form 1985)* – This form is only used if QAI performs QA verification inspection on bar reinforcement for prefabricated bridge element systems (PBES) or other products that contain complex reinforcement as directed by the SFU.

2. *Fabrication Inspection Report (Form 5617)* – This form (or Consultant's company form) must be completed by QAI on a weekly basis for each project and should contain a brief narrative of the work performed over the reporting period and include photos when necessary while omitting emotions and personal feelings. Refer to the Narrative Report Writing subsection in this document for requirements.

3. *Field and Lab Test Report (Form 0590)* – This form must be completed by QAI for each pour which may contain several products.

4. *Materials Source List (Form 0501)* – This form is submitted by the Fabricator to the SFU.
5. *Pre and Post Pour Inspection Checklist (Form 5616)* – This checklist must be completed by QAI for a minimum of one element per project.
6. *Fabrication Inspection File Checklist (Form 2001)* – This form must be completed by QAI for each project. The checklist is placed on top of the fabrication inspection file when the project is complete.
7. *Repair Observation Report (Form 1981)* – This form is only used if QAI performs QA verification inspection on R-2 mortar repair procedures or as directed by the SFU for repairs that have been approved by the Engineer.
8. *Sample Identification (Form 1923)* – This form must be submitted when material sampling is required on a project. QAI must completely fill out the form and keep a copy in the fabrication inspection folder.

2.1.6 Stockpile Payment

This stockpile payment section directs the QAI on the requirements when stockpile payment inspection is requested by the SFU. The QAI must perform the following steps:

1. Verify fabricated material meets approved shop drawings (if applicable).
2. Verify stockpile quantity and include quantity in report.
3. Verify material is labeled for MDOT use only.
4. Verify material is correctly stored and protected from the weather; and
5. Provide a report summarizing the inspection and provide adequate photos that represent the general condition of the products, how they are being stored, and piece marks.

2.1.7 Acceptance

A. Bill of Lading

The Fabricator is required to provide the QAI with a minimum of five (5) copies of the Bill of Lading for each shipment. QAI will stamp each copy of the Bill of Lading with the MDOT "Approved for Use" stamp and will retain one copy for their records. It is the Fabricator's responsibility to distribute the remaining copies of Bill of Lading to the following individuals:

1. Engineer
2. Contractor
3. Trucking company

The Bill of Lading is required to contain, at a minimum, the following information:

1. Shipping date
2. Description of cargo (quantity, element size, weight, etc.)
3. Element unique piece mark
4. MDOT project location (route, crossroad/river, and city)
5. MDOT project information (MDOT ID and job number)
6. Manufacturer's name and address

B. Acceptance Process

Acceptance consists of the following two-part process:

1. Fabrication Inspection Acceptance:

Structural products must be inspected by the QAI after they are loaded for shipping. If the structural products meet the contract requirements, the QAI will stamp them "Approved for Use". The products must be stamped "Approved for Use" prior to shipping. Additionally, the QAI must stamp at least five copies of the Bill of Lading that is prepared by the Fabricator. The approval stamp is for use by MDOT and does not relieve the Contractor of their responsibility to meet contract requirements.

2. VI Acceptance:

The Engineer must collect one copy of the stamped Bill of Lading and use it to verify the delivered structural products. Additionally, the Engineer must verify that the products are stamped and VI them for signs of damage that may have occurred due to shipping and handling. This VI should be documented in the field inspector's daily report.

2.2 Prestressed Structural Precast Concrete Fabrication

2.2.1 Scope

This prestressed structural precast concrete fabrication inspection procedure should be used to aid the QAI in interpreting and enforcing the contract for prestressed concrete products. Fabrication inspection includes the time from verifying materials used for fabrication through loading for shipping to the construction site. The following prestressed structural precast concrete products are inspected using this procedure:

1. Bridge main members
2. Bridge secondary members
3. Culverts
4. Prefabricated bridge element systems
5. Noise barrier wall posts and panels
6. Other products specified in the contract or directed by Engineer

2.2.2 Reference Documents

A. QAI must have a thorough knowledge of the following references:

1. MDOT Structural Fabrication Quality Manual (michigan.gov)
2. Materials Quality Assurance Procedures (MQAP) (michigan.gov)
3. MDOT Materials Source Guide
4. Applicable sections of the MDOT 2020 Standard Specifications for Construction [WEB]-linked (michigan.gov)as modified by Supplemental Specification for Errata to the 2020 Standard Specifications
5. Applicable Frequently Used Special Provisions:

20SP-105A	Source of Steel and Iron (Buy America)
20SP-406A	Revisions to Precast Three-Sided, Arch, and Box Culverts

20SP-707G	Structural Steel Diaphragms for Prestressed Concrete Beams
20SP-708A	Quality Control and Acceptance of Structural Precast Concrete
20SP-826I	Spun Concrete Pole and Drilled Shaft Foundation

6. Prefabrication meeting minutes (if applicable)

B. QAI must be familiar with the following references:

1. Michigan Test Methods

MTM 108	Michigan Test Method for Materials Finer than No. 75 Sieve in Mineral Aggregates by Washing
MTM 109	Michigan Test Method for Sieve Analysis of Fine, Dense Graded, Open Graded, and Coarse Aggregates in the Field
MTM 110	Michigan Test Method for Determining Deleterious and Objectionable Particles in Aggregates

2. ASTM Standards

C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
C94	Standard Specification for Ready-Mixed Concrete
C138	Test Method for Density (Unit Weight), Yield and Air Content (Gravimetric) of Concrete
C143	Standard Test Method for Slump of Hydraulic Cement Concrete
C172	Standard Practice for Sampling Freshly Mixed Concrete
C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
C1064	Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
E29	Standard Practice for using Significant Digits in Test Data to Determine Conformance with Specifications

3. PCI MNL-116 Manual for Quality Control for Plants and Production of Structural Precast Concrete Products
4. Fabricator's QSM and QC procedures
5. PCI Safety and Loss Prevention Manual SLP-100
6. MDOT Accident Prevention Plan

2.2.3 Qualifications, Responsibilities, Duties, and Equipment

2.2.3.1 Qualifications of the QAI

QAI performing the fabrication inspection must possess the following qualifications:

1. Michigan Professional Engineer (PE) license or Precast/Prestressed Concrete Institute (PCI) Technician Level II.

2. Michigan Concrete Association (MCA) Level I Field Testing Technician certification or American Concrete Institute (ACI) Concrete Field Testing Technician – Grade I (except period of effectiveness will be reduced from 5 years to 3 years to match MCA); and

3. If aggregate sampling or testing is performed, QAI must possess the necessary Michigan Certified Aggregate Technician (MCAT) Level I, Level II, or ACI Aggregate Testing Technician – Level I certification.

2.2.3.2 Responsibilities of the QAI

QAI performing the fabrication inspection is not permitted to make changes to the contract and has the following responsibilities:

The Contractor, Fabricator, and MDOT will approach quality control and quality assurance as a team effort to facilitate accurate and timely construction. QAI's verification does not relieve the Fabricator from the responsibility to perform the required testing and inspection to produce a product satisfying the contract. Though QA inspection may include all aspects of fabrication, the QAI must not supersede QC, which is the responsibility of the Fabricator. If QC is not accomplishing its role, then the SFU, Engineer, Contractor, and Fabricator must determine the necessary corrections.

QAI is the responsible party, representing the Engineer, who performs quality assurance verification inspection on the element after QC inspects and approves the item of work. The QAI must provide inspection during fabrication as directed by the SFU and must perform each inspection item shown in subsections 2.2.4.3 thru 2.2.4.10 a minimum of once per project or per the project ITP whichever is more frequent. If issues arise, it will be at the Engineer's discretion whether to increase the level of QA inspection.

It is the Engineer's responsibility to engage the EOR when making structural decisions. The Engineer is also responsible for following internal MDOT procedures for review and approval of shop drawings, fabrication procedures, RFIs, NCRs, and for professional decision making on fabrication problems that arise. The Engineer relies on the SFU to manage and assist when appropriate. The Engineer has the prerogative for holding a prefabrication meeting with the Fabricator to discuss and clarify the contract plans and specifications. The Engineer is the responsible party who ensures MDOT's fabrication QA program is followed for inspection and acceptance of the product.

Fabrication should proceed only with approved shop drawings. However, if the Fabricator must proceed prior to receipt of approved shop drawings (performing work at their own risk), ensure that the SFU is aware of this activity and await instruction on how to proceed. If the Engineer permits the work to proceed without approved shop drawings, proceed with basic QA functions using the non-approved shop drawings. Later, verify notes against approved drawings. Notify the SFU immediately if fabrication is not in conformance with the approved shop drawings.

2.2.3.3 Duties of the QAI

QAI performing the fabrication inspection has the following duties:

1. QAI must thoroughly understand the contract.

2. QAI must verify steel material certifications show compliance with BA contract requirements.

3. QAI must be proficient in performing fresh concrete tests, sampling aggregate and other materials, verifying material traceability, and inspecting concrete pours.

4. QAI must be proficient in writing reports and using computers.

5. QAI must notify the SFU if production begins before approved shop drawings are on the shop floor and provided to the QAI.

6. QAI must communicate all concerns through QCI or whomever the Fabricator directs during the prefabrication meeting.
7. QAI must communicate with QCI to obtain the work schedule.

2.2.3.4 Deficiencies on LAP Projects

MDOT's QAI must notify the SFU if they observe fabrication or inspection deficiencies on LAP projects. The Structural Fabrication Engineer will report the deficiencies via email to the Engineer that is responsible for construction oversight of the LAP project and carbon copy the applicable CFS and Design Division LAP Engineers.

2.2.3.5 Inspection Facilities and Access

Facilities for the QAI must be provided by the Fabricator per contract. QAI must always have access to all parts of the work. The authority and general duties of the QAI are specified in subsections 104.01.D and E of the SSC.

2.2.3.6 Inspection Equipment

QAI will be furnished with the following items by the SFU:

1. Contract (SSC, special provisions, standard plans, special details, plan sheets, etc.)
2. Approved shop drawings (provided by Fabricator)
3. MDOT shop approval stamp
4. Numbered plastic sample tags, sampled adhesive tags for material sampling, and numbered metallic MDOT sample tags

QAI must provide the following inspection equipment:

1. Computer with high-speed internet access
2. Cell phone
3. Digital camera (can be integral with cell phone)
4. Flashlight
5. Temperature measuring devices capable of covering from 0°F to 200°F
6. Fresh concrete testing equipment (thermometer, slump cone kit, and air-meter)
7. Measuring devices (20-foot and 200-foot steel tape and calipers)
8. Straightedge and levels
9. Safety equipment
10. Other equipment as needed

2.2.4 Inspection Procedure

2.2.4.1 Prefabrication Meeting

Prefabrication meetings facilitate effective quality control and quality assurance on the project and are conducted by the SFU prior to the start of fabrication and preferably after shop drawings have been approved. The SFU, QAI, Fabricator, and QCI must attend (in person or virtual), whereas the Engineer and Contractor should attend (in person or virtual) to ensure a team effort to facilitate accurate and timely construction. Quality assurance and quality control contact information will be shared during this meeting to ensure effective communication.

2.2.4.2 Inspection Overview

Prestressed concrete must be fabricated in accordance with the SSC and the contract. Fabrication inspection is performed in accordance with the ITP specified in the MDOT WA.

1. Prestressed concrete fabrication inspection consists of verifying compliance with the approved shop drawings, contract, and approved NCRs. RFIs must be incorporated into the approved shop drawings for the QAI to inspect to.
2. An approved MSL, submitted by the Fabricator to the SFU for review and approval, is provided to the QAI so that the QAI knows what materials are being incorporated into the project and what the basis of acceptance is. The MSL is used to initiate conversation about who will perform the QA sampling and testing and foster communication between QA and QC to ensure all required sampling and testing occurs in a timely manner to prevent impacts to the project schedule. It is the Fabricator's responsibility to notify the QAI when materials are available for sampling.
3. QAI begins by inspecting materials that will be used in the fabrication process and verifies they are being stored correctly, tagged for traceability purposes, and are in conformance with the contract. Next, the QAI observes the Fabricator's operations to verify the type and condition of the equipment meet the contract.
4. MDOT's Accident Prevention Plan states, "MDOT employees shall not engage in any act which would endanger another employee or themselves". QAI must notify the SFU immediately if work conditions exist that are not safe. If the level of inspection diminishes below what is specified in this QA procedure, due to safety concerns, then the element will not be approved for use.

2.2.4.3 Strand Verification

General Information – While the strand is still visible, the QAI must inspect the strands to assure that they are free of oil or other foreign material. Strands not free of oil or foreign material, or that contain kinks, bends, nicks, or other defects (including scale or excessive rust) will be brought to QCs attention that incorporation of these nonconforming strands will render the element unacceptable, and the element will not be approved for use.

A. Strands are positioned to duplicate the strand pattern shown on the approved shop drawings. Changing the vertical position of the strands must have the approval of the Engineer. Changing the horizontal position of the strands to simplify fabrication or to accommodate two strand patterns on a bed is permitted provided the following is still achieved:
    1. Specified concrete cover.
    2. Center to center distance of strands is at least 2 inches.
    3. Number of strands per row is maintained; and
    4. Resulting strand pattern is symmetrical about the vertical centerline of the element.

B. Two strand patterns are permitted to be combined on a casting bed provided the following conditions are met and approved by the Engineer:

   1. Strand debonding must be placed on the entire length of the additional strands that are included in each element. Debonding material requires the approval of the Engineer.

   2. Maximum of two full length debonded strands per element.

C. All supports used to position the strand rows must be of adequate thickness to hold the true position of the strands.

D. Inspection of the tensioning operation consists of verifying the jack is calibrated and observing the accurate introduction of the initial load in each of the strands. Final stressing of the strands is performed by application of load into each strand or all the strands at once to produce an elongation equaling a ***net elongation*** (gross elongation minus live end seating). The QAI must verify the allowable stress in each strand by measuring the ***net elongation*** of the individual strands after the final stressing. The maximum load applied to each strand, as indicated by the pressure gauge of the tensioning device, is also recorded for back checking.

E. QAI must complete independent strand tensioning calculations for verification purposes with QC.

2.2.4.4 Strand Tensioning

The QAI must verify the load (measured in pounds) and elongation (measured in inches) applied to each strand using the following procedures:

A. Initial Load

After all strands are positioned on the casting bed each strand is secured by a strand-vise at the dead-end anchoring bulkhead of the casting bed. Each strand is individually fitted at the live end anchoring bulkhead (tensioning end) of the casting bed and an ***initial load*** is applied either one strand at a time or all at once. The ***initial load*** must be designated by the Fabricator and must be within 5 and 25 percent of the final load. Allow a ± 100 pound measurement tolerance for loads less than or equal to 10 percent of the final load, and a ± 200 pound measurement tolerance for loads greater than 10 percent of the final load.

When the ***initial load*** is reached, a reference mark is made on the strand on the outside of the live end anchoring bulkhead such that measurement of continued elongation can be observed. The purpose of applying an ***initial load*** to each strand is to establish a constant starting point for measuring the ***net elongation*** measurements by eliminating slack in the system.

B. Final Load

Final load is the force required beyond ***initial load.*** At this time, the strand pattern is checked at each bulkhead to make certain all strands are in their correct position and none of the strands are crossed.

C. Net Elongation

Using the strand mark from the previous step (after initial load) the final load is applied to the strand. The distance between the strand mark and the reference point must be measured to the nearest 0.0625 inches to determine when the ***net elongation*** *is reached*. If the measured elongation is within 5 percent of the computed elongation, the tensioning operation is complete.

Changes in live end seating loss over time may result in insufficient over-pull. PCI requires the plant personnel to monitor the changes and adjust the required over-pull accordingly. If there is a need for arbitration a reasonable approach is suggested here for a predetermined number of strands. When the tensioning operation for each strand is complete and before the tension is released from the jack, a second reference mark must be made on the strand at the inside of the anchoring plate and the strand-vise must then be tapped into position against the outside face of the

anchoring plate. When the tension has been released from the jack the QAI must check the reference marks on the strand at the inside of the anchoring plate to determine that no slippage of the strand-vise (live end seating loss) has occurred. If slippage has occurred, then it must be compared to the assumed live end seating loss used in the strand tensioning calculations.

D. Strand Elongation

The tensioning operation must be stopped immediately whenever the strand is elongating without a corresponding increase in the load, or the load increases without a continuing increase in strand elongation. In these occurrences, the following steps must be taken:

1. Strand elongation computation is checked.
2. Casting bed length is verified.
3. Modulus of elasticity of the strand is verified; and
4. Factors restricting the free movement of the strand are reviewed.

Temperature changes may affect the hydraulic system of the tensioning apparatus resulting in variations in load readings.

E. Tensioning Draped Strands

QAI must be alert to the strand elongation and tensioning operation discussed above. In some cases, the number and efficiency of hold-down/hold-up hardware may restrict the free movement of a strand over the entire bed length resulting in a continuing elongation of strand without a corresponding increase in the load. When this situation occurs, the tensioning operation is stopped and the remaining elongation developed in the strand taken by tensioning the strand from the opposite end of the casting bed.

F. Confirming Uniform Elongation of Draped Strands

This can be accomplished by marking-off a 10-foot (or more if available) length of draped strand at the opposite end of the bed after the initial load operation has been completed. At the completion of the final measured elongation operation, the measured distance between the marks should have increased to the ***net elongation*** computation for a 10-foot strand length (or whatever was initially marked off).

G. Wire Failure in Strand

See PCI MNL 116 for acceptance of failure of individual wires in a pretensioning strand.

2.2.4.5 Forming and Casting

1. General Information

QAI must confirm the dimensional requirements of the bulkheads, side forms, bearing plates, steel reinforcement, void boxes, inserts, and any other devices per the approved shop drawings as part of their post-pour inspection. The only exception is that anything that cannot be inspected post-pour, must be inspected during pre-pour. It is important to emphasize that QA must not supersede QC so the QAI's inspection must come after QC has completed their inspection and approves the element. QAI then uses the QC inspection reports (if available) during their verification inspection.

2. Concrete Forms - Concrete forms must be maintained and remain true to the shapes and dimensions as shown on the approved drawings.
    a. Metal forms must be used since they are designed and aligned to not restrict the longitudinal movement of the casting when the prestressing force is transferred. Forms must be well braced and stiffened against undesirable deformations under pressure of fresh concrete and must have smooth joints and inside surfaces accessible for adequate cleaning after each use.

b. Joints between panel forms must be made and maintained smooth and tight. Unless otherwise shown on approved shop drawings, all corners or intersections of surfaces exposed in the completed structure must be chamfered with a minimum dimension of 0.50 inches and all re-entrant angles must be rounded with a minimum radius of 0.75 inches.

c. Forms that are warped, distorted, damaged, or improperly cleaned must not be used. Wood forms may be used for bulkheads. The inside faces of all forms must be coated with an approved chemical release agent.

3. Reinforcing Steel

QAI must confirm that the reinforcing steel is of the correct size, free from defects, and properly positioned. The reinforcing steel must be free of oil, lubricants, foreign material, and excessive rust. If epoxy coated bars are to be used, then nicks in the coating are not permitted.

QAI must spot check that the reinforcing steel has been properly positioned and secured in accordance with the approved shop drawings and make certain that inserts have been placed where required.

4. Void Boxes

Void boxes must be of the dimensions and positioned in the form in accordance with the approved shop drawings.

After the bar reinforcement assembly has been positioned in the formwork, the QAI must confirm that the void boxes are securely clamped to the formwork so they cannot move out of position during consolidation activities. After the unit has been cast, and immediately after the top has been struck-off, the top slab thickness must be confirmed by the QAI to assure that there has been no upward movement of the void box and that the top slab thickness is within the acceptable specification limits. The depth of concrete over the void boxes will be spot checked and any concerns noted and immediately shared with QC.

5. Tests on Fresh Concrete

QAI must perform testing as required in the contract and document the results in *MDOT Form 0590*. The Fabricator must collect additional fresh concrete for QAI to perform their tests as needed.

6. Placing of Concrete

The concrete must be promptly placed with minimum handling to avoid segregation of the materials and the displacement of the reinforcement. Each element must be cast in a continuous operation with minimal interruption between the placing of adjacent portions of concrete and each layer must be placed and consolidated before the preceding layer has taken initial set.

7. Consolidation of Concrete

A minimum amount of vibration necessary to thoroughly consolidate the concrete must be used. QAI must verify a rubber coated vibrator head is used when epoxy-coated or other coated reinforcement is used.

2.2.4.6 Transfer of Prestress

The tension in the strands must not be transferred to the concrete in the element until the concrete has attained the required compressive strength as indicated by test results of QC compressive strength test cylinders which have been cast and match cured per the contract.

1. Forms are removed, and the strands are released by simultaneously cutting both ends of the same strand using a torch or other method approved by the Engineer. The Fabricator must release strands in a symmetrical pattern about the vertical centerline. Extreme care must be exercised by the Fabricator to avoid damaging the concrete by superheating it with the torch.

2. Products are moved from the casting bed to the yard upon completion of the transfer of prestress. After removal from the bed, the QAI must immediately inspect the element for any defects created during casting and perform post-pour inspections after QC has completed their inspection and approves the element. QAI must note any deficiencies on Form 5617 and immediately notify the Fabricator and Engineer.

2.2.4.7 Curing Requirements

Curing requirements for prestressed concrete must be as specified in subsection 708.03 of the SSC as modified by the contract or as specified in other contract documents. When steam or radiant heat curing is used, recording thermometers must be provided by the Fabricator that monitors the time/temperature relationship through the curing period while artificial heat is used. The QAI must verify that the recording thermometers are placed in critical locations for monitoring the time/temperature relationship during the curing period. Verify QC has the required number of recording thermometers per the contract, and they are placed at locations where the anticipated heat generated by the concrete is the lowest and highest just after initial concrete set. Documentation from the Fabricator's recording thermometer must be given to the QAI for their review. Temperature requirements during the curing operation must be in accordance with the contract specifications.

2.2.4.8 Material Requirements

Materials must meet the requirements of the contract unless an RFI requesting alternate materials has been approved by the Engineer.

2.2.4.9 Shipping Requirements

Products must attain the required compressive strength as indicated by test results of QC compressive strength test cylinders, which have been cast and match cured for this purpose as described per the contract. These cylinders must be cast with numbered metallic MDOT sample tags.

2.2.4.10 Concrete Compression Strength Testing

QAI must witness concrete strength testing at the sampling frequency of the governing ITP. Watch for specimen ID, handling, machine condition, and QC procedural compliance. Verify proper interpretation and reporting of results by the QCI.

2.2.5 Reports

A. The Engineer may require a periodic status report from the SFU; therefore, all reports are required to be completed in a timely and orderly manner using the applicable forms listed below that can be found on MDOT's website. Make entries as soon as possible after an event or conversation to ensure accuracy. Number the reports consecutively until completion of the work with the last report noted "final".

B. QAI must complete an accurate and detailed account of fabrication for the project. The report must include a discussion of fabrication progress for all aspects of the work. It is intended to be a detailed record of the status of fabrication and should include number of products fabricated, documentation of specification and procedure compliance as well as documentation of conflicts, repairs, and other problems or discussion which could affect the project in any way. If force account work is taking place, document each day that the work occurs in the shop and which products are being worked on.

C. Documentation is not a substitute for appropriate dialogue with the Fabricator but should provide a record of important discussions. In some cases, the QAI is more familiar with the events or issues and therefore should review and comment on draft copies of the SFU's correspondence.

D. Reports must be assembled into one fabrication inspection PDF file and stored in MDOT's ProjectWise document storage program per subsection 1.8 of this document.

E. Below is a list of various MDOT forms and a brief description of their purpose and use requirement. Similar forms can be used in place of the standard MDOT form if noted below. All completed forms or equivalent forms are placed in the fabrication inspection file at the end of the project.

1. *Bar Reinforcement Report (Form 1985)* – This form is only used if QAI performs QA verification inspection on bar reinforcement for prefabricated bridge element systems (PBES) or other products that contain complex reinforcement as directed by the SFU.

2. *Fabrication Inspection Report (Form 5617)* – This form (or Consultant's company form) must be completed by QAI on a weekly basis for each project and should contain a brief narrative of the work performed over the reporting period and include photos when necessary while omitting emotions and personal feelings. Refer to the Narrative Report Writing subsection in this document for requirements.

3. *Field and Lab Test Report (Form 0590)* – This form must be completed by QAI for each pour which may contain several products.

4. *Materials Source List (Form 0501)* – This form is submitted by the Fabricator to the SFU.

5. *Pre and Post Pour Inspection Checklist (Form 5616)* – This checklist must be completed by the QAI.

6. *Fabrication Inspection File Checklist (Form 2001)* – This form must be completed by QAI for each project. The checklist is placed on top of the fabrication inspection file when the project is complete.

7. *Repair Observation Report (Form 1981)* – This form is only used if QAI performs QA verification inspection on R-2 Mortar repair procedures or as directed by the SFU for other types of repairs.

8. *Sample Identification (Form 1923)* – This form must be submitted when material sampling is required on a project. QAI must completely fill out the form and keep a copy in the fabrication inspection file.

9. *Strand Tensioning Report (Form 0513)* – This form must be completed by QAI for each bed, which may contain several products.

2.2.6 Stockpile Payment

This stockpile payment section directs the QAI on the requirements when stockpile payment inspection is requested by the SFU. The QAI must perform the following steps:

1. Verify fabricated material meets approved shop drawings (if applicable).
2. Verify stockpile quantity and include quantity in report.
3. Verify material is labeled for MDOT use only.
4. Verify material is correctly stored and protected from the weather; and
5. Provide a report summarizing the inspection and provide adequate photos that represent the general condition of the products, how they are being stored, and piece marks.

2.2.7 Acceptance

A. Bill of Lading

The Fabricator is required to provide the QAI with a minimum of five (5) copies of the Bill of Lading for each shipment. QAI will stamp each copy of the Bill of Lading with the MDOT "Approved for Use" stamp. It is the Fabricator's responsibility to distribute the stamped copies of Bill of Lading to the following individuals:

1. Engineer
2. Contractor
3. Trucking company

The Bill of Lading is required to contain, at a minimum, the following information:

1. Shipping date
2. Description of cargo (quantity, element size, weight, etc.)
3. Element unique piece mark
4. MDOT project location (route, crossroad/river, and city)
5. MDOT project information (MDOT ID and job number)
6. Manufacturer's name and address

B. Acceptance Process

Acceptance consists of the following two-part process:

1. Fabrication Inspection Acceptance: Structural products must be inspected by the QAI after they are loaded for shipping. If the structural products meet the contract requirements, the QAI will stamp them "Approved for Use". The products must be stamped "Approved for Use" prior to shipping. Additionally, the QAI must stamp at least five copies of the Bill of Lading that is prepared by the Fabricator. The approval stamp is for use by the MDOT and does not relieve the Contractor of their responsibility to meet contract requirements.
2. VI Acceptance: The Engineer must collect one copy of the stamped Bill of Lading and use it to verify the delivered structural products. Additionally, the Engineer must verify that the products are stamped and VI them for signs of damage that may have occurred due to shipping and handling. This VI should be documented in the field inspector's daily report.

2.3 Bridge Steel Fabrication

2.3.1 Scope

This bridge steel fabrication inspection procedure should be used to aid the QAI in interpreting and enforcing the contract for bridge main member and secondary member products. Fabrication inspection includes the time from verifying materials used for fabrication through loading for shipping to the construction site. The following products are inspected using this procedure:

1. Bridge main member
2. Bridge secondary member
3. Bridge bearings
4. Other products specified in the contract or directed by Engineer

2.3.2 Reference Documents

A. QAI must have a thorough knowledge of the following references:

1. MDOT Structural Fabrication Quality Manual (michigan.gov)
2. Materials Quality Assurance Procedures (MQAP) (michigan.gov)
3. MDOT Materials Source Guide
4. Applicable sections of the MDOT 2020 Standard Specifications for Construction [WEB]-linked (michigan.gov)as modified by Supplemental Specification for Errata to the 2020 Standard Specifications
5. Applicable Frequently Used Special Provisions:

20SP-105A	Source of Steel and Iron (Buy America)
20SP-707A	Structural Steel and Aluminum Construction
20SP-707B	Modular Bridge Joint System
20SP-707E	Prefabricated Steel Pedestrian Bridge, Type 1
20SP-707F	Prefabricated Steel Pedestrian Bridge, Type 2
20SP-707G	Structural Steel Diaphragms for Prestressed Concrete Beams
20SP-707H	Digital Radiography in Structural Steel Fabrication
20SP-716B	Revisions to Shop Cleaning and Coating Structural Steel

6. AASHTO/AWS D1.5 Bridge Welding Code (as modified by 20SP-707A), hereafter called AWS D1.5
7. AWS D1.6 Structural Welding Code – Stainless Steel
8. Prefabrication meeting minutes (if applicable)

B. QAI must be familiar with the following references:

1. AISC 207 Certification Standard for Steel Fabrication and Erection, and Manufacturing of Metal Component
2. ANSI/AISC 303 Code of Standard Practice for Steel Building and Bridges
3. AISC 420 Certification Standard for Shop Application of Complex Protective Coating
4. RCSC Specification for Structural Joints Using High-Strength Bolts
5. AWS A2.4 Symbols for Welding and Nondestructive Testing
6. AWS A3.0 Standard Welding Terms and Definitions
7. Applicable AMPP (formerly SSPC) specifications
8. Applicable ASTM and AASHTO specifications
9. Fabricator's QSM and QC procedures
10. MDOT Accident Prevention Plan

2.3.3 Qualifications, Responsibilities, Duties, and Equipment

2.3.3.1 Qualifications of the QAI

QAI performing the fabrication inspection must possess an active AWS Certified Welding Inspector (CWI) certification.

2.3.3.2 Responsibilities of the QAI

QAI performing the fabrication inspection is not permitted to make changes to the contract and has the following responsibilities:

The Contractor, Fabricator, and MDOT will approach quality control and quality assurance as a team effort to facilitate accurate and timely construction. QAI's verification does not relieve the Fabricator from the responsibility to perform the required testing and inspection to produce a product satisfying the contract. Though QA inspection may include all aspects of fabrication, the QAI must not supersede QC, which is the responsibility of the Fabricator. If QC is not accomplishing its role, then the SFU, Engineer, Contractor, and Fabricator must determine the necessary corrections.

QAI is the responsible party, representing the Engineer, who performs quality assurance verification inspection on the product after QC inspects and approves the item of work. The QAI must provide inspection during fabrication as directed by the SFU and must perform each inspection item shown in subsections 2.3.4.3 thru 2.3.4.7 a minimum of once per project or per the project ITP whichever is more frequent. If issues arise, it will be at the Engineer's discretion whether to increase the level of QA inspection.

It is the Engineer's responsibility to engage the EOR when making structural decisions. The Engineer is also responsible for following internal MDOT procedures for review and approval of shop drawings, fabrication procedures, RFIs, NCRs, and for professional decision making on fabrication problems that arise. The Engineer relies on the SFU to manage and assist when appropriate. The Engineer has the prerogative for holding a prefabrication meeting with the Fabricator to discuss and clarify the contract plans and specifications. The Engineer is the responsible party who ensures MDOT's fabrication QA program is followed for inspection and acceptance of the product.

Fabrication should proceed only with approved shop drawings. However, if the Fabricator must proceed prior to receipt of approved shop drawings (performing work at their own risk), ensure that the SFU is aware of this activity and await instruction on how to proceed. If the Engineer permits the work to proceed without approved shop drawings, proceed with basic QA functions using the non-approved shop drawings. Later, verify notes against approved drawings. Notify the SFU immediately if fabrication is not in conformance with the approved shop drawings.

2.3.3.3 Duties of the QAI

QAI performing the fabrication inspection has the following duties:

1. QAI must thoroughly understand the contract.
2. QAI must verify steel material certifications show compliance with BA contract requirements.
3. QAI must be proficient in testing welders, sampling materials, verifying material traceability, and inspecting welds and coating systems.
4. QAI must be proficient in writing reports and using computers.
5. QAI must notify the SFU if production begins before approved shop drawings are on the shop floor and provided to the QAI.
6. QAI must communicate all concerns through QCI or whomever the Fabricator directs during the prefabrication meeting.
7. QAI must communicate with QCI to obtain the work schedule.

2.3.3.4 Deficiencies on LAP Projects

MDOT's QAI must notify the SFU if they observe fabrication or inspection deficiencies on LAP projects. The Structural Fabrication Engineer will report the deficiencies via email to the Engineer that is responsible for construction oversight of the LAP project and carbon copy the applicable CFS and Design Division LAP Engineers.

2.3.3.5 Inspection Facilities and Access

Facilities for the QAI must be provided by the Fabricator per contract. QAI must always have access to all parts of the work. The authority and general duties of the QAI are specified in subsections 104.01.D and E of the SSC.

2.3.3.6 Inspection Equipment

QAI will be furnished with the following items by the SFU:

1. Contract (SSC, special provisions, standard plans, special details, plan sheets, etc.)
2. Approved shop drawings (provided by Fabricator)
3. MDOT shop approval stamp
4. Numbered plastic sample tags and adhesive tags for material sampling
5. Plastic bags for sampling high strength bolts

QAI must provide the following inspection equipment:

1. Computer with high-speed internet access
2. Cell phone
3. Digital camera (can be integral with cell phone)
4. Flashlight
5. Fillet weld gauges
6. Undercut gauges
7. Instrumentation for measuring voltage and amperage
8. Temperature measuring devices capable of covering from 0°F to 1650°F
9. Dry film thickness gauges
10. Wet film paint thickness gauge
11. Surface roughness comparator gauge
12. Extra course replica tape for measuring blasted steel surface profile
13. SSPC book of pictorial blast standards
14. Temperature and humidity measuring instruments
15. Measuring devices (20-foot and 200-foot steel tape and calipers)
16. Straightedge and levels
17. Safety equipment
18. Other equipment as needed

2.3.4 Inspection Procedure

2.3.4.1 Prefabrication Meeting

Prefabrication meetings facilitate effective quality control and quality assurance on the project and are conducted by SFU prior to the start of fabrication and preferably after shop drawings have been approved. The SFU, QAI, Fabricator, and QCI must attend (in person or virtual), whereas the Engineer and Contractor should attend (in person or virtual) to ensure a team effort to facilitate accurate and timely construction. Quality assurance and quality control contact information will be shared during this meeting to ensure effective communication.

2.3.4.2 Inspection Overview

Bridge main and secondary members must be fabricated in accordance with the SSC and contract. Fabrication inspection is performed in accordance with the ITP specified in the MDOT WA and as shown below:

1. Bridge fabrication inspection consists of verifying compliance with the approved shop drawings, contract, and approved NCRs. RFIs must be incorporated into the approved shop drawings for the QAI to inspect to.

2. A MSL is not required for bridge projects due to the shop drawing containing a material listing (bill of material) and only a couple materials (high strength bolts and anchor rods) that share the same basis of acceptance (Test). The SFU will notify the Fabricator if a MSL is required for more complex project. The process outlined in 2.1.4.2 or 2.2.4.2 would be followed.

3. QAI begins by inspecting materials that will be used in the fabrication process and verifies they are being stored correctly, tagged for traceability purposes, and are in conformance with the contract. Next, the QAI observes the Fabricator's operations to verify the type and condition of the equipment meet the contract.

4. MDOT's Accident Prevention Plan states, "MDOT employees shall not engage in any act which would endanger another employee or themselves". QAI must notify the SFU immediately if work conditions exist that are not safe. If the level of inspection diminishes below what is specified in this QA procedure, due to safety concerns, then the product will not be approved for use.

2.3.4.3 Before Welding

Below is a checklist for the QAI to use for fabrication inspection prior to the start of welding. The actual steps and their exact sequence will depend upon the type of structure, the method of erection, and the qualifications of the welders who are to do the work.

1. Verify mill test reports match the base metal for conformance with the specifications. Verify that QC is maintaining traceability of all materials to such degree that the heat number of each piece of steel that is used in the project can be tracked to its location in the structure. Obtain from the Fabricator, if necessary, the shipping records, storage locations, and scheduling for each piece of steel that they intend to use in connection with the assigned contract. Examine each piece of steel as it is received at the shop to see that it has no uncorrected defects, kinks, or bends resulting from improper handling while in the mill or shop or in transit from mill to shop. Verify that the material from the mill meets ASTM A6.

2. Verify all welders are MDOT qualified (see Annex for more information on MDOT's Welder Qualification Program) and have appropriate fracture critical qualification, if applicable. Recommend requalification or supplementary welder tests to the SFU if there are concerns. Only welders listed on the *MDOT Welder Qualification Test Request* (Form 0571) approved by the SFU may be tested. MDOT's SSC requires that all tack welders, welders, and welding operators be current MDOT qualified welders for the welding process, plate thickness, position, etc. prior to welding.

3. Verify that the WPS and welding sequences are agreed to and understood by QAI, QC, and Fabricator prior to welding. All WPSs and PQRs are required to be reviewed and approved by the SFU. The Contract requires all WPSs to be qualified as required in the related welding code prior to welding. This qualification requirement is inclusive of all types of welds (butt welding, fillet welding, seal welding, plug welding, etc.). MDOT will accept prequalified WPSs if they meet all the prequalification requirements of the welding code. MDOT also accepts properly documented evidence of previous PQRs that have not expired. See the contract for specific WPS and PQR requirements. The Fabricator is required to post approved WPS's at each welding station.

4. Make a general examination of the steel and verify the quality of fabrication. Pay attention to the plate edge preparation, which would affect control over welding. Notify QC of any observed deficiencies before weld joint fit up is complete so they can correct any deficiencies.

5. Check the fitting of joints that are to be welded, including dimensions of root face, angle of bevel, cleanliness, match marks, alignment of parts to be joined, and uniformity and size of root openings. Recheck root faces and angles of bevel because trimming and re-beveling of plate edges is sometimes performed during fitting. Check the prepared weld joint edges for evidence of possible undesirable internal defects such as laminations in the steel plate. Make dimensional checks of all critical measurements to assure a proper fit in the field.

6. Check the fixture, clamping, and pre-cambering arrangements used in the fabrication assembly setup for adequacy. Make certain tack welds are made by MDOT qualified welders and the welds are small, smooth, and of specified quality. Verify that runoff tabs or extension plates are in place to facilitate complete welding beyond the plate edges.

2.3.4.4 During Welding

1. Verify all welding is being performed using the approved WPS and sequences (if applicable) and electrodes are used with suitable currents and polarity for the positions the electrodes are intended to be used. Refer to the approved WPS for all details of performing the weld in question.

2. During inclement weather, verify suitable windbreaks or shields are provided, and welding is not performed on surfaces that are wet, exposed to rain or snow, or if a heavy fog is present. Check the ambient and steel temperatures at the start of welding and during welding to determine if the specified preheat and interpass temperature requirements are being observed. Use temperature-indicating crayons or other equivalent means to check these temperatures.

3. Check to make certain the correct electrodes (type and size) are available and are properly dried to prevent porosity and hydrogen cracking in the final welds. Low-hydrogen electrodes are susceptible to these types of defects if they are exposed to the atmosphere beyond the recommended limits. If electrodes and fluxes have been improperly stored or exposed to humidity in excess of the recommended limits, notify QC that reconditioning, or rejection is required per the contract.

4. Intermittently observe the technique and performance of each welder to verify the approved WPS and suitable techniques are being followed. Inspect important or unique joints multiple times to verify all weld passes meet project specifications. Arrange for the welder or the foreman to notify the QAI when such inspections at various stages may be made. Report any unusual or excessive distortion during welding to QC. Verify all corrective measures are being followed as approved by the Engineer to minimize locked-in stresses.

5. Verify the welding arc is only struck in the joint or other area on which metal is to be deposited and not at random locations on the base metal outside of the prepared joint. Arc strikes cause physical and metallurgical stress risers and can change the mechanical properties of the steel at isolated locations. These changes can result in fatigue failures. Verify that approval by the Engineer has been given to the Fabricator prior to ground bars, clips, or ties being welded to the base metal. Approval for such welding is only given by the Engineer when unavoidable. When steel ground bars are used instead of ground clamps to carry the welding current to the base metal, make certain the ground bars are carefully welded to the base metal at a runoff tab or securely clamped to any area where all mill scale has been removed. Verify the grounding lead is as close to the point of welding as is practical.

6. Inspect root passes with special care because it is very important the first weld materials deposited in the root of a multiple pass weld is properly performed. Closely examine the root pass in important complete joint penetration welds, such as flange and web butt welds, t-joint, and corner joints to verify a sound pass that is free from cracks, inclusions, and lack of fusion.

7. Verify the root pass and every subsequent weld pass is cleaned with a wire brush and chipping hammer to thoroughly remove slag between weld passes to avoid inclusions. Verify defects and substandard workmanship in any weld pass be removed by chipping or gouging before subsequent passes of metal are deposited. Peening or consolidating of weld metal by hammering is not permitted without the approval of the Engineer. Under conditions of very severe restraint, minimize weld cracking by acceptable techniques such as a cascade build-up sequence. Avoid any interruptions in the welding of a critical joint other than those necessary to change electrodes and quickly clean the slag from each pass before the next pass is deposited.

8. Verify the Fabricator is not creating re-entrants or local areas with high residual stresses in highly stressed parts of main members. Where beam flanges do not match well at butt welded splices, the Fabricator should deposit the weld metal in such a way as to provide a smooth transition between the parts being joined. Verify that temporary fitting aids, such as plates and angles, are not applied at highly stressed locations and that temporary tack welds are not allowed.

9. Check all members to verify the welds are of proper size and length, are being made in the proper location to conform to the approved shop drawings and are performed in such a manner as to produce weld metal conforming to the contract. To determine whether the weld metal is being deposited in such a manner as to penetrate well into the root of a joint without producing excessive slag inclusions or porosity, a field test may be conducted by making a T-joint with a fillet weld on only one side of the stem of the T. This joint can be broken open easily for visual examination. If welds are to be ground smooth and flush for any reason, verify grinding is performed so grinding marks are not left transverse to the direction of the primary stress in a member. Verify welds are not being over ground resulting in a "dished" surface. Verify the ends of welds are being ground smooth after runoff tabs are removed.

10. Verify the Fabricator identifies with paint (does not stamp steel) each splice of main member with the symbol of the welder doing the work. If two welders work on such a splice, verify the symbol of each and record, in writing, the work each welder performed.

11. Record progress of fabrication on *MDOT Form 5617*. Include the dates that the work was completed and pertinent remarks regarding problems encountered, and corrective action taken.

2.3.4.5 After Welding

1. Verify welds are cleaned of slag and weld spatter so they can be given a thorough final examination. Verify the surfaces of the welds are reasonably smooth and of suitable contour without evidence of undercut, overlap, excessive convexity, insufficient throat or leg size, unfilled craters at the ends of welds, or other defects in excess of the limits prescribed by the contract. Refer to the contract for the appearance of welds containing these various kinds of defects. Verify all scars and defects, such as undercutting or remnant portions of tack welds and other scars that are left after the removal of temporary fitting and erection clips are corrected to be within the tolerances specified.

2. Check the storage, loading, blocking, and handling of the welded members to avoid distortion or structural damage. Verify braces or lugs are not welded to the members.

3. Verify the final camber and required curvature (or sweep) of all girders after all fabrication steps have been completed by observing QC perform their inspection. The SFU will notify the QAI if they are required to perform QA inspection using the appropriate MDOT forms. Any members that measure out of tolerance must be noted for corrective action and rechecked after the correction has been made.

2.3.4.6 NDT

Also known as NDE, NDT is the responsibility of the Fabricator per the contract. QAI verifies the NDT requirements of the contract are correctly performed and documented. Knowledge of the principles and procedures of NDT is essential for QAI to verify QC during NDT.

Verify the required testing is performed and documented as required in the contract. Verify that the weld surface and adjacent plate surfaces are in satisfactory condition prior to NDT.

Verify NDT QCIs are ASNT Level II or III or otherwise qualified as required by the applicable welding code by reviewing certification records.

Check the performance of NDT QCIs at frequent intervals to verify approved procedures are being used, all weld joints to be tested are examined in accordance with contract and results are recorded. QAI should witness NDT of all critical splices. Collect all NDT reports generated and submit to the SFU with the final documentation package.

Verify QC identifies locations of all rejected welds. Observe the excavation of defects and the use of MT inspection to verify no part of the defect remains. Verify that the Fabricator follows all approved weld repair plans.

Perform visual testing inspection after blast-cleaning the base metal for weld surface defects, weld finish, and edge and hole finish requirements.

A. NDT Inspection Methods

Typically, the inspection methods acceptable for MDOT work are:

1. Visual testing (VT) inspection
2. Penetrant testing (PT) inspection
3. Magnetic particle testing (MT) inspection
4. Ultrasonic testing (UT) inspection
5. Radiographic testing (RT) inspection

See the contract documents for unique and alternate NDT methods and requirements.

B. Interpretation

The interpretation of all NDT is the responsibility of the Fabricator's QC personnel. QAI is responsible for reviewing all the Fabricator's interpretations and calling any disagreements to the attention of the SFU. The Engineer's interpretation is final, and they may also call for additional testing to further explore a discrepancy.

C. Converting Conventional RT Film to Digital Images

Fabricators are required to convert conventional radiographic film, if used, to digital images for final project record (aka digitizing). Conversion is performed either on site or at a specialized facility, and either throughout the project or at the end of the project, but in any case, prior to shipping steel.

Through the oversight described below, MDOT is assured that the converted digital images meet the quality requirements of 20SP-707H and Clause 8, Part B of the AASHTO/AWS D1.5M/D1.5:2020 Bridge Welding Code.

A written procedure for digitizing the film is submitted by the Fabricator and approved by MDOT prior to testing. Verify the Fabricator has an approved procedure preferably prior to startup, but at least prior to testing.

Before testing and accepting welds, assure the written procedure is demonstrated to the satisfaction of the Engineer or designated representative, and documented in the final report. Assure qualified staffing witness the performance demonstration confirming the essential variables (equipment and technique) and qualified personnel are consistent with the written procedure and 20SP-707H. During conversion, system verifications are performed by the Fabricator or its vendor. Assure qualified staffing confirms satisfactory verifications through observation and/or review of documented evidence, either onsite or remotely.

Prior to shipping, verify digitization is complete and documented. This is done at the shop directly or via receipt of digital documents and hard drive from an offsite film-processing center. Use the FCS or qualified NDT technician to dispute any disagreements with the Fabricator and escalate disputes to the Engineer for further evaluation if necessary.

At the end of the project, transfer custody of the digital images and backup hard drive to MDOT. Verify the hard drive is properly labeled with MDOT JN and ID (including control section and structure number). Depending on the project, digital images may be uploaded directly to ProjectWise or other established FTP site. Hard drives are stored at an MDOT facility.

2.3.4.7 Inspection of Shop Cleaning and Coating Fabricated Steel

QAI is responsible for verifying that QC is being effective and enforcing all cleaning and coating contract requirements. All MDOT steel bridge contracts specify a high technology coating system. Most steel bridges are completely shop coated (i.e., primer, intermediate, and topcoat) by the Fabricator. The essential phases of inspecting a coating system are summarized below:

1. Environmental Conditions

The contract includes specific controls on environmental conditions (e.g., temperature, humidity, cleanliness, air movement, shading, etc.). These conditions must be strictly enforced.

2. Coating Materials

All paints must be carefully mixed, thinned, and handled in accordance with the manufacturer's specifications. Verify QC is recording all batch numbers used for comparison to the certification documents. Verify the color numbers of the topcoat for conformance to the approved shop drawings. Verify all materials do not exceed the required expiration date.

3. Cleaning and Coating Equipment

High technology coating systems employ the most sophisticated blast cleaning and spray-painting equipment developed. A thorough knowledge of their operation and use is required by the QAI. QAI is responsible for evaluating the performance of the equipment prior to coating the steel. If any of the equipment is operating outside of the specification limits the coatings will not be properly applied and may fail (peeling) at some time after application.

4. Steel Surface Conditions

All grinding, weld repairs, and fabrication steps must be completed before blast cleaning and painting. Any remedial work performed after coating may be grounds for rejection of the coating system. The steel must be free of all traces of grease and oil before blast cleaning is performed.

5. Surface Preparation

Verify QC is monitoring surface cleanliness and surface profile using specialized equipment per the contract.

6. Coating Application

QAI must verify that the proper techniques of applying the high technology coating systems is being performed. Improper application techniques may "appear" to give acceptable results but

will lead to a greatly reduced performance life and possibly an early coating failure (blistering and peeling). QAI must verify QC is monitoring all environmental conditions before and during the coating process. Correction (if required) must be taken on each coat of the painting system before the next coat is applied. Verify that approved coating repair procedures are followed.

7. Documentation

Documentation of an approved coating on the steel consists of the QC test reports on the coating evaluations and environmental conditions as well as a certificate of compliance from the paint manufacturer. MDOT coating systems are in a QPL found in the MSG. The certificate of compliance attests that the painting materials supplied are the same as those submitted to MDOT for acceptance testing.

8. Handling, Storage, and Repair

QAI must verify all contract for handling, storage, and repair of shop painted steel are strictly followed. All paint damages during handling and loading by the Fabricator must be repaired using approved procedures prior to QAI's approval for shipping.

2.3.5 Reports

A. The Engineer may require a periodic status report from the SFU; therefore, all reports are required to be completed in a timely and orderly manner using the applicable forms listed below that can be found on MDOT's website. Make entries as soon as possible after an event or conversation to verify accuracy. Number the reports consecutively until completion of the work with the last report noted "final".

B. QAI must complete an accurate and detailed account of fabrication for the project. The report must include a discussion of fabrication progress for all aspects of the work. It is intended to be a detailed record of the status of fabrication and should include number of products fabricated, documentation of specification and procedure compliance as well as documentation of conflicts, repairs, and other problems or discussion which could affect the project in any way. If force account work is taking place, document each day that the work occurs in the shop and which products are being worked on.

C. Documentation is not a substitute for appropriate dialogue with the Fabricator but should provide a record of important discussions. In some cases, the QAI is more familiar with the events or issues and therefore should review and comment on draft copies of the SFU's correspondence.

D. Reports must be assembled into one fabrication inspection PDF file and stored in MDOT's ProjectWise document storage program per subsection 1.8 of this document.

E. Below is a list of various MDOT forms and a brief description of their purpose and use requirement. Similar forms can be used in place of the standard MDOT form if noted below.

1. *Fabrication Inspection Report (Form 5617)* – This form (or Consultant's company form) must be completed by QAI on a weekly basis for each project and should contain a brief narrative of the work performed over the reporting period and include photos when necessary while omitting emotions and personal feelings. Refer to the Narrative Report Writing subsection in this document for requirements.

2. *Fabrication Inspection File Checklist (Form 1942)* – This form must be completed by QAI for each project. The checklist is placed on top of the fabrication inspection file when the project is complete.

3. *Sample Identification (Form 1923)* – This form must be submitted to the MDOT Metals Lab along with the sample when material sampling is required on a project. QAI must completely fill out the form and keep a copy in the fabrication inspection file.

4. *Welder Qualification Test Request (0571)* – This form must be completed by the Fabricator, submitted to the SFU, and approved by the SFU prior to the start of welder qualification testing.

2.3.6 Stockpile Payment

This stockpile payment section directs the QAI on the requirements when stockpile payment inspection is requested by the SFU. The QAI must perform the following steps:

1. Verify plate/rolled material is traceable to the mill certifications and meets ASTM A6 (if applicable).
2. Verify fabricated material meets approved shop drawings (if applicable).
3. Verify stockpile quantity and include quantity in report.
4. Verify material is labeled for MDOT use only.
5. Verify material is correctly stored and protected from the weather; and
6. Provide a report summarizing the inspection and provide adequate photos that represent the general condition of the products, how they are being stored, mill markings or piece marks, and mill certifications for plate/rolled material if applicable.

2.3.7 Acceptance

A. Bill of Lading

The Fabricator is required to provide the QAI with a minimum of five (5) copies of the Bill of Lading for each shipment. QAI will stamp each copy of the Bill of Lading with the MDOT "Approved for Use" stamp and will retain one copy for their records. It is the Fabricator's responsibility to distribute the remaining copies of Bill of Lading to the following individuals:

1. Engineer
2. Contractor
3. Trucking company

The Bill of Lading is required to contain, at a minimum, the following information:

1. Shipping date
2. Description of cargo (quantity, product size, weight, etc.)
3. Product unique piece mark
4. MDOT project location (route, crossroad/river, and city)
5. MDOT project information (MDOT ID and job number)
6. Manufacturer's name and address

B. Acceptance Process

Acceptance consists of the following two-part process:

1. Fabrication Inspection Acceptance: Structural products must be inspected by the QAI after they are loaded for shipping. If the structural products meet the contract requirements, the QAI will stamp them "Approved for Use". All main members must be stamped "Approved for Use" prior to shipping; some secondary and miscellaneous components will not be individually stamped. Additionally, the QAI must stamp at least five copies of the Bill of Lading that is prepared by the Fabricator. The approval stamp is for use by the MDOT and does not relieve the Contractor of their responsibility to meet contract requirements.
2. VI Acceptance: The Engineer must collect one copy of the stamped Bill of Lading and use it to verify the delivered structural products. Additionally, the Engineer must verify that the products are stamped and VI them for signs of damage that may have occurred due to shipping and handling. This VI should be documented in the field inspector's daily report.

2.4 Structural Steel Fabrication

2.4.1 Scope

This structural steel fabrication inspection procedure should be used to aid the QAI in interpreting and enforcing the contract for steel highway structures, bridge railing, bridge deck grating, and miscellaneous structural steel. Fabrication inspection includes the time from verifying materials used for fabrication through loading for shipping to the construction site. The following products are inspected using this procedure:

1. Traffic sign support structures:
    - Cantilever
    - Truss
    - Dynamic message sign
    - Bridge sign connections
2. Tower lighting unit
3. Traffic signal mast arm pole and mast arm
4. Bridge railing
5. Bridge grid decks and sidewalks
6. Other products specified in the contract or directed by Engineer

2.4.2 Reference Documents

A. QAI must have a thorough knowledge of the following references:

1. MDOT Structural Fabrication Quality Manual
2. MDOT Materials Quality Assurance Procedures Manual
3. MDOT Materials Source Guide
4. Applicable sections of the MDOT 2020 Standard Specifications for Construction [WEB]-linked (michigan.gov)as modified by Supplemental Specification for Errata to the 2020 Standard Specifications
5. Applicable Frequently Used Special Provisions:

20SP-105A	Source of Steel and Iron (Buy America)
20SP-707A	Structural Steel and Aluminum Construction

20SP-716A	Coating of Galvanized Lighting, Signal, Sign, and Miscellaneous Support Structures
20SP-716B	Revisions to Shop Cleaning and Coating Structural Steel
20SP-810B	Traffic Signal Mast Arm Pole and Mast Arm
20SP-826J	Dynamic Message Sign Support Structure
20SP-826-K	Small Dynamic Message Sign Support Structure
20SP-919A	Permanent Traffic Sign and Support Material Revisions

6. AWS D1.1 Structural Welding Code – Steel (as modified by 20SP-707A), hereafter called AWS D1.1
7. AWS D1.2 Structural Welding Code – Aluminum (as modified by 20SP-707A), hereafter called AWS D1.2
8. Prefabrication meeting minutes (if applicable)

B. QAI must be familiar with the following references:

1. AISC 207 Certification Standard for Steel Fabrication and Erection, and Manufacturing of Metal Component
2. ANSI/AISC 303 Code of Standard Practice for Steel Building and Bridges
3. AISC 420 Certification Standard for Shop Application of Complex Protective Coating
4. RCSC Specification for Structural Joints Using High-Strength Bolts
5. AWS A2.4 Symbols for Welding and Nondestructive Testing
6. AWS A3.0 Standard Welding Terms and Definitions
7. Applicable AMPP (formerly SSPC) specifications
8. Applicable ASTM and AASHTO specifications
9. Fabricator's QSM and QC procedures
10. MDOT Accident Prevention Plan

2.4.3 Qualifications, Responsibilities, Duties, and Equipment

2.4.3.1 Qualifications of the QAI

QAI performing the fabrication inspection must possess an active AWS Certified Welding Inspector (CWI) certification.

2.4.3.2 Responsibilities of the QAI

QAI performing the fabrication inspection is not permitted to make changes to the contract and has the following responsibilities:

The Contractor, Fabricator, and MDOT will approach quality control and quality assurance as a team effort to facilitate accurate and timely construction. QAI's verification does not relieve the Fabricator from the responsibility to perform the required testing and inspection to produce a product satisfying the contract. Though QA inspection may include all aspects of fabrication, the QAI must not supersede QC, which is the responsibility of the Fabricator. If QC is not accomplishing

its role, then the SFU, Engineer, Contractor, and Fabricator must determine the necessary corrections.

QAI is the responsible party, representing the Engineer, who performs quality assurance verification inspection on the product after QC inspects and approves the item of work. The QAI must provide inspection during fabrication as directed by the SFU and must perform each inspection item shown in subsections 2.4.4.3 thru 2.4.4.8 below a minimum of once per project or per the project ITP. If issues arise, it will be at the Engineer's discretion whether to increase the level of QA inspection.

It is the Engineer's responsibility to engage the EOR when making structural decisions. The Engineer is also responsible for following internal MDOT procedures for review and approval of shop drawings, fabrication procedures, RFIs, NCRs, and for professional decision making on fabrication problems that arise. The Engineer relies on the SFU to manage and assist when appropriate. The Engineer has the prerogative for holding a prefabrication meeting with the Fabricator to discuss and clarify the contract plans and specifications. The Engineer is the responsible party who ensures MDOT's fabrication QA program is followed for inspection and acceptance of the product.

Fabrication should proceed only with approved shop drawings. However, if the Fabricator must proceed prior to receipt of approved shop drawings (performing work at their own risk), ensure that the SFU is aware of this activity and await instruction on how to proceed. If the Engineer permits the work to proceed without approved shop drawings, proceed with basic QA functions using the non-approved shop drawings. Later, verify notes against approved drawings. Notify the SFU immediately if fabrication is not in conformance with the approved shop drawings.

2.4.3.3 Duties of the QAI

QAI performing the fabrication inspection has the following duties:

1. QAI must thoroughly understand the contract.
2. QAI must verify steel material certifications show compliance with BA contract requirements.
3. QAI must be proficient in testing welders, sampling materials, verifying material identification, and inspecting welds and coating systems.
4. QAI must be proficient in writing reports and using computers.
5. QAI must notify the SFU if production begins before approved shop drawings are on the shop floor and provided to the QAI.
6. QAI must communicate all concerns through QCI or whomever the Fabricator directs during the prefabrication meeting.
7. QAI must communicate with QCI to obtain the work schedule.

2.4.3.4 Deficiencies on LAP Projects

MDOT's QAI must notify the SFU if they observe fabrication or inspection deficiencies on LAP projects. The Structural Fabrication Engineer will report the deficiencies via email to the Engineer that is responsible for construction oversight of the LAP project and carbon copy the applicable CFS and Design Division LAP Engineers.

2.4.3.5 Inspection Facilities and Access

Facilities for the QAI must be provided by the Fabricator per contract. QAI must always have access to all parts of the work. The authority and general duties of the QAI are specified in subsections 104.01.D and E of the SSC.

2.4.3.6 Inspection Equipment

QAI will be furnished with the following items by the Engineer:

1. Contract (SSC, special provisions, standard plans, special details, plan sheets, etc.)
2. Approved shop drawings (provided by Fabricator)
3. MDOT shop approval stamp
4. Numbered plastic sample tags and sampled adhesive tags for material sampling
5. Plastic bags for sampling high strength bolts

QAI must provide the following inspection equipment:

1. Computer with high-speed internet access
2. Cell phone
3. Digital camera (can be integral with cell phone)
4. Flashlight
5. Fillet weld gauges
6. Undercut gauges
7. Instrumentation for measuring voltage and amperage
8. Temperature measuring devices capable of covering from 0°F to 1650°F
9. Dry film thickness gauges
10. Wet film paint thickness gauge
11. Surface roughness comparator gage
12. Extra course replica tape for measuring blasted steel surface profile
13. SSPC book of pictorial blast standards
14. Temperature and humidity measuring instruments
15. Measuring devices (20-foot and 200-foot steel tape and calipers)
16. Straightedge and levels
17. Safety equipment
18. Other equipment as needed

2.4.4 Inspection Procedure

2.4.4.1 Prefabrication Meeting

Prefabrication meetings facilitate effective quality control and quality assurance on the project and are conducted by the SFU prior to the start of fabrication and preferably after shop drawings have been approved. The SFU, QAI, Fabricator, and QCI must attend (in person or virtual), whereas the Engineer and Contractor should attend (in person or virtual) to ensure a team effort to facilitate accurate and timely construction. Quality assurance and quality control contact information will be shared during this meeting to ensure effective communication.

2.4.4.2 Inspection Overview

Structural steel must be fabricated in accordance with the SSC and contract. Fabrication inspection is performed in accordance with the ITP specified in the MDOT WA and as shown below:

1. Structural steel fabrication inspection consists of verifying compliance with the approved shop drawings, contract, and approved NCRs. RFIs must be incorporated into the approved shop drawings for the QAI to inspect to.
2. A MSL is not required for structural steel projects due to the shop drawing containing a material listing (bill of material) and only a couple materials (high strength bolts and anchor rods) that share the same basis of acceptance (Test). The SFU will notify the Fabricator if a MSL is required for more complex project. The process outlined in 2.1.4.2 or 2.2.4.2 would be followed.
3. QAI begins by inspecting materials that will be used in the fabrication process and verifies they are being stored correctly, identified for traceability purposes, and are in conformance with the contract. Next, the QAI observes the Fabricator's operations to verify the type and condition of the equipment meet the contract.
4. MDOT's Accident Prevention Plan states, "MDOT employees shall not engage in any act which would endanger another employee or themselves". QAI must notify the SFU immediately if work conditions exist that are not safe. If the level of inspection diminishes below what is specified in this QA procedure, due to safety concerns, then the product will not be approved for use.

2.4.4.3 Before Welding

Below is a checklist for the QAI to use for fabrication inspection prior to the start of welding. The actual steps and their exact sequence will depend upon the type of structure, the method of erection, and the qualifications of the welders who are to do the work.

1. Verify mill test reports match the required material specification and grade of the base metal. Verify that QC is maintaining traceability of all materials to such degree that the heat number of each piece of steel that is used in the project is identified. Obtain from the Fabricator, if necessary, the shipping records, storage locations, and scheduling for each piece of steel that they intend to use in connection with the assigned contract. Examine stored or staged steel as it is received at the shop to see that it has no uncorrected defects, kinks, or bends. Observe QC activities of ensuring or restoring material to ASTM A6 conformance.
2. Verify all welders are MDOT qualified (see Annex for more information on *MDOT's Welder Qualification Program*). Recommend requalification or supplementary welder tests to the SFU if there are concerns. Only welders listed on the *MDOT Welder Qualification Test Request* (Form 0571) approved by the SFU may be tested. MDOT's SSC requires that all tack welders, welders, and welding operators be current MDOT qualified welders for the welding process, plate thickness, position, etc. prior to welding.
3. Verify that the WPS and welding sequences are agreed to and understood by QAI, QC, and Fabricator prior to welding. All WPSs and PQRs are required to be reviewed and approved by the SFU. The Contract requires all WPSs to be qualified as required in the related welding code prior to welding. This qualification requirement is inclusive of all types of welds (butt welding, fillet welding, seal welding, plug welding, etc.). MDOT will accept prequalified WPSs if they meet all the requirements of the code for prequalification. MDOT also accepts properly documented evidence of previous PQRs that have not expired. See the contract for specific WPS and PQR requirements. The Fabricator is required to post approved WPS's at each welding station.

4. Make a general examination of the structural steel and verify the quality of fabrication. Pay attention to the plate edge preparation, which would affect control over welding. Notify QC of any observed deficiencies before weld joint fit up is complete so they can correct any deficiencies.

5. Check the fitting of joints that are to be welded, including dimensions of root face, angle of bevel, cleanliness, match marks, alignment of parts to be joined, and uniformity and size of root openings. Recheck root faces and angles of bevel because trimming and re-beveling of plate edges is sometimes performed during fitting. Check the prepared weld joint edges for evidence of possible undesirable internal defects such as laminations in the steel plate. Make dimensional checks of all critical measurements to assure a proper fit in the field.

6. Check the fixture, clamping, and pre-cambering arrangements used in the fabrication assembly setup for adequacy. Make certain tack welds are made by MDOT qualified welders and the welds are small, smooth, and of specified quality. Verify that runoff tabs or extension plates are in place to facility complete welding beyond the plate edges.

2.4.4.4 During Welding

1. Verify all welding is being performed using the approved WPS and sequences (if applicable) and electrodes are used with suitable currents and polarity for the positions the electrodes are intended to be used. Refer to the approved WPS for all details of performing the weld in question.

2. During inclement weather, verify that suitable windbreaks or shields are provided, and welding is not performed on surfaces that are wet, exposed to rain or snow, or if a heavy fog is present. Check the ambient and steel temperatures at the start of welding and during welding to determine if the specified preheat and interpass temperature requirements are being observed. Use temperature-indicating crayons or other equivalent means to check these temperatures.

3. Check to make certain the correct electrodes (type and size) are available and are properly dried to prevent porosity and hydrogen cracking in the final welds. Low-hydrogen electrodes are susceptible to these types of defects if they are exposed to the atmosphere beyond the recommended limits. If electrodes and fluxes have been improperly stored or exposed to humidity more than the recommended limits, notify QC that reconditioning, or rejection is required per the contract.

4. Intermittently observe the technique and performance of active welders to verify the approved WPS and suitable techniques are being followed. Randomly observe individual weld pass quality meets project specifications. Arrange for the welder or the foreman to notify the QAI when such inspections at various stages may be made. Report any unusual or excessive distortion during welding to QC. Verify all corrective measures (e.g., heat correction) are being followed per the Fabricator's plan that has been pre-approved by the Engineer to minimize locked-in stresses.

5. Verify the welding arc is only struck in the joint or other area on which metal is to be deposited and not at random locations on the base metal outside of the prepared joint. Arc strikes cause physical and metallurgical stress risers and can change the mechanical properties of the steel at isolated locations. These changes can result in fatigue failures. Verify that approval by the Engineer has been given to the Fabricator prior to ground bars, clips, or ties being welded to the base metal. Approval for such welding is only given by the Engineer when unavoidable. When steel ground bars are used instead of ground clamps to carry the welding current to the base metal, make certain the ground bars are carefully welded to the base metal at a runoff tab or securely clamped to any area where all mill scale has been removed. Verify the grounding lead is as close to the point of welding as is practical.

6. Inspect root passes with special care because it is very important the first weld materials deposited in the root of a multiple pass weld is properly performed. Closely examine the root pass in important complete joint penetration welds, such as pole to base plate and splices to verify a sound pass that is free from cracks, inclusions, and lack of fusion.

7. Verify the root pass and every subsequent weld passes are cleaned with a wire brush and chipping hammer to thoroughly remove slag between weld passes to avoid inclusions. Observe defects and substandard workmanship in any weld pass are removed by chipping or gouging before subsequent passes of metal are deposited. Peening or consolidating of weld metal by hammering is not permitted without the approval of the Engineer. Under conditions of very severe restraint, observe techniques that minimize weld cracking such as a cascade build-up sequence. Observe that welders avoid interruptions in the welding of a critical joint other than those necessary to change electrodes and quickly clean the slag from each pass before the next pass is deposited.

8. Verify the Fabricator is not creating re-entrants or local areas with high residual stresses in highly stressed parts of main members. Verify that temporary fitting aids, such as plates and angles, are not applied at highly stressed locations and that temporary tack welds are not allowed.

9. Check random members to verify the welds are of proper size and length, are being made in the proper location to conform to the approved shop drawings and are performed in such a manner as to produce weld metal conforming to the contract. To determine whether the weld metal is being deposited in such a manner as to penetrate well into the root of a joint without producing excessive slag inclusions or porosity, a field test may be conducted by making a T-joint with a fillet weld on only one side of the stem of the T. This joint can be broken open easily for visual examination. Verify welds are not being over ground resulting in a "dished" surface. Verify the ends of welds are being ground smooth after runoff tabs are removed.

10. Spot check the traceability of welders to their welds. Verify the Fabricator identifies with paint (do not steel stamp) the symbol of the welder doing the work. If two welders work on single weld, verify the symbol of each and record, in writing, the work each welder performed.

11. Record progress of fabrication on MDOT Form 5617. Include the dates that the work was completed and pertinent remarks regarding problems encountered, and corrective action taken.

2.4.4.5 After Welding

1. Spot-check welds to verify they are cleaned of slag and weld spatter so they can be given a thorough final examination. Verify the surfaces of welds are reasonably smooth and of suitable contour without evidence of undercut, overlap, excessive convexity, insufficient throat or leg size, unfilled craters at the ends of welds, or other defects more than the limits prescribed by the contract. Refer to the contract for the appearance of welds containing these various kinds of defects. Verify scars and defects, such as undercutting or remnant portions of tack welds and other scars that are left after the removal of temporary fitting and erection clips are corrected to be within the tolerances specified.

2. Observe the storage, loading, blocking, and handling of the welded members to avoid distortion or structural damage. Verify braces or lugs are not welded to the members.

3. Verify the final camber and required curvature (or sweep) of all members after all fabrication steps have been completed by observing QC perform their inspection. The Engineer will notify the QAI if they are required to perform QA inspection using the appropriate MDOT forms. Any members that measure out of tolerance are considered nonconforming.

4. VT flange(s) using a straight edge for flatness to assure that full contact of flanges is obtained in an unbolted relaxed condition. Inspect structural products for straightness, and flange bolt hole alignment. Observe the bolting of truss sections to verify proper alignment and bolt tightening procedures (truss sign supports only).

2.4.4.6 NDT

Also known as NDE, NDT Is the responsibility of the Fabricator per the contract. QAI verifies the NDT requirements of the contract are correctly performed and documented. Knowledge of the principles and procedures of NDT is essential for QAI to verify QC during NDT.

Verify the required testing is performed and documented as required in the contract. Verify that the weld surface and adjacent plate surfaces are in satisfactory condition prior to NDT.

Verify NDT QCIs are ASNT Level II by reviewing certification records.

Check the performance of NDT QCIs at frequent intervals to verify approved procedures are being used, all weld joints to be tested are examined in accordance with contract and results are recorded. QAI must witness NDT of first splice and pole and arm to transverse connection plate. Collect all NDT reports generated and submit to the SFU with the final documentation package.

Verify QC identifies locations of all rejected welds. Observe the excavation of defects and the use of MT inspection to verify no part of the defect remains. Verify that the Fabricator follows all approved weld repair plans.

Perform VT after blast-cleaning the base metal for weld surface defects, weld finish, and edge and hole finish requirements.

A. NDT Inspection Methods

Typically, the inspection methods acceptable for MDOT work are:

1. VT inspection of weldments must be in accordance with the contract.
2. PT inspection of weldments must be in accordance with the contract.
3. MT inspection of weldments must be in accordance with the contract.
4. UT inspection of weldments must be in accordance with the contract.
5. RT inspection of weldments must be in accordance with the contract.

See the contract documents for unique and alternate NDT methods and requirements.

B. Interpretation

The interpretation of all NDT is the responsibility of the Fabricator's QC personnel. QAI is responsible for reviewing all the Fabricator's interpretations and calling any disagreements to the attention of the SFU. The Engineer's interpretation is final, and they may also call for additional testing to further explore a discrepancy.

2.4.4.7 Inspection of Shop Cleaning and Coating Fabricated Steel

QAI is responsible for verifying that QC is being effective and enforcing all cleaning and coating contract requirements.

A. Hot-Dip Galvanizing

All MDOT highway structures, bridge railing, and deck grating require hot-dip galvanizing (HDG) and may be coated using a high technology wet coating system or dry system per the contract. HDG must be inspected by the Fabricator and verified (spot-checked) by the QAI for conformance to the applicable ASTM and contract. Unless specified in the contract documents or in the MDOT WA, QAI verification includes:

1. Material Preparation by the Fabricator

Structural members are detailed and fabricated with drainage and venting provisions. Pre-galvanizing surface preparation is completed per project requirements. Members are identified with metal tags or other means and methods agreed upon by both the Fabricator and the galvanizer. Instructions to the galvanizer are documented and include project-specific requirements.

2. Receipt Inspection after Galvanizing (when applicable)

Documentation by the galvanizer is complete including inspection records. Member identification is maintained. VI and spot checks of the coating integrity are performed by the Fabricator. Repairs, if required, are completed per project requirements. Other related nonconformance such as damage or distortion is identified and resolved.

B. Coating Over Galvanizing

The essential phases of inspecting are summarized below:

1. Environmental Conditions

Contract includes specific controls on environmental conditions (e.g., temperature, humidity, cleanliness, air movement, shading, etc.). These conditions must be strictly enforced.

2. Coating Materials

All paints must be carefully mixed, thinned, and handled in accordance with the manufacturer's specifications. Verify QC is recording all batch numbers used for comparison to the certification documents. Verify the color numbers of the topcoat for conformance to the approved shop drawings. Verify all materials do not exceed the required expiration date.

3. Cleaning and Coating Equipment

High technology coating systems employ the most sophisticated blast cleaning and spray-painting equipment developed. A thorough knowledge of their operation and use is required by the QAI. QAI is responsible for evaluating the performance of the equipment prior to the coating of the structural steel. If any of the equipment is operating outside of the specification limits the coatings will not be properly applied and may fail (peeling) at some time after application.

4. Steel Surface Conditions

Surfaces are prepared for coating including any solvent or blast cleaning. The steel must be free of all traces of grease and oil before blast cleaning is performed.

All grinding, weld repairs, and fabrication steps were completed before galvanizing. Any remedial work performed after coating may be grounds for rejection of the coating system.

5. Surface Preparation

Verify QC is monitoring surface cleanliness and surface profile using specialized equipment per the contract.

Smoothing, cleaning, and profiling of galvanized surfaces conforms to project requirements. These requirements include ASTM D6386 *Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Painting* and referenced SSPC SP16 *Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel*.

6. Coating Application

QAI must verify that the proper techniques of applying the high technology coating systems are being performed. Improper application techniques may "appear" to give acceptable results but will lead to a greatly reduced performance life and possibly an early coating failure (blistering and peeling). QAI must verify QC is monitoring all environmental conditions before and during the coating process. Correction (if required) must be taken on each coat of the painting system before the next coat is applied. Verify that approved coating repair procedures are followed.

7. Documentation

Documentation of an approved coating on structural steel consists of the QC test reports on the coating evaluations and environmental conditions as well as a certificate of compliance from the paint manufacturer. MDOT coating systems are in a QPL found in the MSG. The certificate of compliance attests that the painting materials supplied are the same as those submitted to MDOT for acceptance testing.

8. Handling, Storage, and Repair

QAI must verify all contract for handling, storage, and repair of shop painted steel are strictly followed. All paint damages during handling and loading by the Fabricator must be repaired using approved procedures prior to QAI's approval for shipping.

2.4.5 Reports

A. The Engineer may require a periodic status report from the SFU; therefore, all reports are required to be completed in a timely and orderly manner using the applicable forms listed below that can be found on MDOT's website. Make entries as soon as possible after an event or conversation to ensure accuracy. Number the reports consecutively until completion of the work with the last report noted "final".

B. QAI must complete an accurate and detailed account of fabrication for the project. The report must include a discussion of fabrication progress for all aspects of the work. It is intended to be a detailed record of the status of fabrication and should include number of products fabricated, documentation of specification and procedure compliance as well as documentation of conflicts, repairs, and other problems or discussion which could affect the project in any way. If force account work is taking place, document each day that the work occurs in the shop and which products are being worked.

C. Documentation is not a substitute for appropriate dialogue with the Fabricator but should provide a record of important discussions. In some cases, the QAI is more familiar with the events or issues and therefore should review and comment on draft copies of the SFU's correspondence.

D. Reports must be assembled into one fabrication inspection PDF file and stored in MDOT's ProjectWise document storage program per subsection 1.8 of this document.

E. Below is a list of various MDOT forms and a brief description of their purpose and use requirement. Similar forms can be used in place of the standard MDOT form if noted below.

1. *Fabrication Inspection Report (Form 5617)* – This form (or Consultant's company form) must be completed by QAI on a weekly basis for each project and should contain a brief narrative of the work performed over the reporting period and include photos when necessary while omitting emotions and personal feelings. Refer to the Narrative Report Writing subsection in this document for requirements.
2. *Fabrication Inspection File Checklist (Form 1942)* – This form must be completed by QAI for each project. The checklist is placed on top of the fabrication inspection file when the project is complete.
3. *Sample Identification (Form 1923)* – This form must be submitted to the MDOT Metals Lab along with the sample when material sampling is required on a project. QAI must completely fill out the form and keep a copy in the fabrication inspection file.
4. *Welder Qualification Test Request (0571)* – This form must be completed by the Fabricator, submitted to the SFU, and approved by the SFU prior to the start of welder qualification testing.

2.4.6 Stockpile Payment

This stockpile payment section directs the QAI on the requirements when stockpile payment inspection is requested by the SFU. The QAI must perform the following steps:

A. Verify plate/rolled material is traceable to the mill certifications and meets ASTM A6 (if applicable).
B. Verify fabricated material meets approved shop drawings (if applicable).
C. Verify stockpile quantity and include quantity in report.
D. Verify material is labeled for MDOT use only.
E. Verify material is correctly stored and protected from the weather; and
F. Provide a report summarizing the inspection and provide adequate photos that represent the general condition of the products, how they are being stored, mill markings or piece marks, and mill certifications for plate/rolled material if applicable.

2.4.7 Acceptance

A. Bill of Lading

The Fabricator is required to provide the QAI with a minimum of five (5) copies of the Bill of Lading for each shipment. QAI will stamp each copy of the Bill of Lading with the MDOT "Approved for Use" stamp and will retain one copy for their records. It is the Fabricator's responsibility to distribute the remaining copies of Bill of Lading to the following individuals:

1. Engineer
2. Contractor
3. Trucking company

The Bill of Lading is required to contain, at a minimum, the following information:

1. Shipping date
2. Description of cargo (quantity, product size, weight, etc.)
3. Product unique piece mark
4. MDOT project location (route, crossroad/river, and city)

5. MDOT project information (MDOT ID and job number)
6. Manufacturer's name and address

B. Acceptance Process

Acceptance consists of the following two-part process:

1. Fabrication Inspection Acceptance: Structural products must be inspected by the QAI after they are loaded for shipping. If the structural products meet the contract requirements, the QAI will stamp them "Approved for Use". All main members must be stamped "Approved for Use" prior to shipping; some ancillary and miscellaneous components will not be individually stamped. Additionally, the QAI must stamp at least five copies of the Bill of Lading that is prepared by the Fabricator. The approval stamp is for use by the MDOT and does not relieve the Contractor of their responsibility to meet contract requirements.
2. VI Acceptance: The Engineer must collect one copy of the stamped Bill of Lading and use it to verify the delivered structural products. Additionally, the Engineer must verify that the products are stamped and VI them for signs of damage that may have occurred due to shipping and handling. This VI should be documented in the field inspector's daily report.

3 Inspection and Test Plans

MDOT has developed several standard inspection and test plans (ITPs) to support the fabrication inspection procedures provided in Section 2 by providing the QAI with a specific plan. QAI activities are listed along with their referenced requirements, activity codes, frequency, basic description, and output/record. Detailed descriptions of these activities are found in the fabrication inspection procedures.

3.1 Hold Points

Some QAI activities are identified as hold points. These are sensitive steps that require QAI notification by the Fabricator. Fabrication must not proceed past these points until the QAI is either satisfied with the outcome through direct testing or observation of QC testing, or the QAI grants a waiver of the hold point based on situational evaluation. QAI satisfaction or waiver does not constitute product acceptance, which is the responsibility of the Fabricator. The phrase "release hold point" means the action of communicating QAI satisfaction or waiver to the Fabricator.

3.2 Establishing and Adjusting the ITP

The pre-Fabrication meeting minute template initially establishes the minimum number of QAI hold points which are identified as the blue shaded rows in the ITP table(s). At the start of fabrication, the QAI may recommend, or request modification or addition of hold points for the approval of the SFU. Rationale for changing any aspect of a hold point (inspection criteria, frequency, or assigning hold point status to an additional activity) must be based on objective evidence and must be discussed with the MDOT Structural Precast Concrete Specialist or the MDOT Structural Steel Specialist prior to notifying the Fabricator of the new inspection requirements.

The QAI may request additional inspections, tests, or hold points during the fabrication process due to established action limits/suspension limits being exceeded or in reaction to a loss of confidence in a process. Additional inspections, tests, or hold points will be conveyed in writing to the Fabricator and must result in minimal impact to project schedule. Written conveyance must identify the duration and acceptance criteria in addition to the same level of detail as in the ITP table. SFU approval is required.

3.3 Communication Between Fabricator and QAI

Ideally, the Fabricator must convey project schedules in writing to confirm when hold point inspections will occur and that the QAI is available for the hold point inspection as requested by the Fabricator. The QAI must reply to any written requests for hold point inspections. Other forms of communication are acceptable if documented (with language clearly defining Fabricator notification to the QAI and QAI response) and agreed to at the prefabrication meeting.

The QAI is encouraged to use the ITP as a tool for communicating expectations to the Fabricator. It is intended to be reviewed at the prefabrication meetings or at any time prior to production startup. Ideally it would be reviewed side by side with the Fabricator's quality control plan or the Fabricator's own ITP to achieve continuity and reduce misunderstanding.

3.4 Standard ITPs and Inspection Levels

ITPs have been developed for the following product types: bridge steel, non-prestressed concrete, prestressed concrete, prestressed spun concrete pole, steel highway structures, and structural steel. The applicable ITP for a given project is communicated in the MDOT WA. Each of these ITPs has two versions of inspection intensity: Level I and Level II. Level I inspection is considered standard shop inspection for main load carrying members, typically requiring full-time presence by a QAI. Level II inspection is considered standard shop inspection for auxiliary load carrying members and ancillary products, typically characterized by reduced inspection frequency and sample size. Complex and unique (e.g., aluminum, carbon fiber, etc.) projects may require a custom ITP to be developed.

Below are MDOT's current standard ITPs that can be found on the SFU website:

- Bridge Steel: Level I ITP
- Non-Prestressed Concrete: Level I ITP
- Prestressed Concrete: Level I ITP
- Steel Highway Structures: Level I ITP
- Structural Steel: Level I ITP
- Prestressed Spun Concrete Pole ITP
- Bridge Steel: Level II ITP
- Non-Prestressed Concrete: Level II ITP
- Prestressed Concrete: Level II ITP
- Steel Highway Structures: Level II ITP
- Structural Steel: Level II ITP
- Steel Casting/Forging ITP

4 Supplier Qualification Program

Supplier qualification requirements differ for each product type, but are based on the Supplier's implementation, maintenance, and auditing of its QMS as a key indicator of its ability to produce a quality product.

MDOT will accept products from suppliers who demonstrate a proactive QMS with procedures and processes that consistently deliver quality to the State. To assess that demonstration of quality, MDOT may rely solely on nationally recognized programs (AISC, PCI, NPCA, etc.) or may perform its own QMS Assessments when specified by project or required by an MDOT Supplier Qualification Standard (SQS).

In addition to requiring current plant certification by nationally recognized programs, project specifications may include a special QMS assessment.

Alternatively, MDOT may require active adherence to a Supplier Qualification Standard (SQS) with administrative rules and specific QMS requirements. Contractors are expected to use only those suppliers who have been identified on the MDOT Approved Supplier List as meeting this standard.

4.1 Supplier Qualification Standard for Prestressed Concrete Beams

The SQS for prestressed concrete bridge beams, can be accessed by clicking the related hyperlink at the end of this subsection or found on the SFU website, consists of two parts: requirements for participation (Program Rules) and minimum QMS requirements (Standard). The Program Rules explain documentation reviews, onsite audits, achieving and maintaining qualification status, and nonconformance resolution. The Standard explains minimum MDOT requirements for a Supplier's documented QMS; the Supplier must have defined processes and documented procedures addressing all the elements in the Standard. Successful assessments to the SQS result in inclusion on the MDOT Approved Supplier List – see below for details.

- MDOT Supplier Qualification Standard for Prestressed Concrete (michigan.gov)

4.2 Supplier Qualification Standard for Steel Highway Structures

The SQS for steel highway structures (including aluminum bridge mounted sign structures), can be accessed by clicking the related hyperlink at the end of this subsection or found on the SFU website, consists of two parts: requirements for participation (Program Rules) and minimum QMS requirements (Standard). The Program Rules explain documentation reviews, onsite audits, achieving and maintaining qualification status, and nonconformance resolution. The Standard explains minimum MDOT requirements for a Supplier's documented QMS; the Supplier must have defined processes and documented procedures addressing all the elements in the Standard. Successful assessments to the SQS result in inclusion on the MDOT Approved Supplier List – see below for details.

- MDOT SQS for Steel Highway Structures

4.3 Reserved for Expansion to Other Products

5 Approved Supplier List:

This section contains MDOT's ASL. Suppliers must successfully demonstrate compliance to the related MDOT SQS to be eligible. See Section 4 for more information about MDOT's supplier qualification program. MDOT's ASL for *Prestressed Concrete Beams* and *Steel Highway Structures* can be found on the SFU website.

6 Buy America Guidance

The purpose of this section is to provide the SFU with guidance to supplement MDOT's Special Provision for Source of Steel and Iron also known as BA. The SFU is responsible for implementing MDOT's quality assurance program for material required to be accepted based on "Fabrication Inspection" per the MQAP manual. It is important to note that this section is not contractual, and all project related decisions should be based on the contract. This guidance section will be used to ensure statewide consistency in performing QA inspection at fabrication facilities for BA compliance. It provides a brief background on FHWA's BA policy, what step certification is, where more BA information can be found, how foreign steel or iron could be incorporated into the project, and tables that provide common steel and iron components used in the fabrication process of structural precast concrete and structural steel elements. This section is broken down into the following:

1. Background
2. Step Certification
3. Foreign Steel or Iron
4. Documentation Requirements
5. BA Tables

6.1 Background

The FHWA's BA policy is based upon the statutory provisions in the Surface Transportation Assistance Act of 1982, as implemented with a November 25, 1983 final rule. FHWA has since issued clarifications and interpretations on the BA policy and standing waiver of 1983 with memo's issued on December 22, 1997, June 13, 2011, and December 21, 2012; however, the December 21, 2012 memo was rescinded on December 22, 2015. In general, FHWA's BA policy requires a domestic manufacturing process for ***all*** steel (including stainless steel; however, brass, bronze and copper are not subject to BA) or iron manufactured products (including the application of protective coatings, but not the coating itself) that are permanently incorporated into a Federal-aid highway construction project.

Title 23 Section 313 and FHWA's regulations in 23 CFR 635.410 provide that the Administrator may issue a waiver. Procedures for any waivers are in the FHWA guidance for BA on the FHWA website. Waivers are very rare and typically take about 9 months to be issued, which would require them to be submitted during the design stage. Additionally, the FHWA's regulations permit a minimal use of foreign steel and iron in the amount of $2,500 or one-tenth of one percent (0.1 percent), whichever is greater, to be used in a Federal-aid project. Note that application of BA is triggered by the obligation of Federal funds. If any amount of federal funding is used in the project, then BA requirements apply. Map 21 requires all parts of a project to comply with BA if any previous parts of the larger project used Federal funds. This includes environmental EIS, planning, design, small subparts, etc. FHWA may issue a standing national or regional waiver if it is warranted, although it is extremely rare.

The waiver would be granted by the Secretary of Transportation if the product is not manufactured in the United States and the public rulemaking process demonstrates that non-domestic availability of the product would adversely impact the Federal-aid program in multiple states, specific region, and/or nationwide.

6.2 Step Certification

Step certification is the process under which each supplier (supplier, fabricator, manufacturer, processor, etc.) of the steel and iron product(s) certifies that their step in the manufacturing process was domestically performed. Contractors must provide manufacturers' step certifications to the Engineer showing the steel and iron products are of domestic origin prior to permanent incorporation into the Federal-aid highway project. MDOT requires step certification for all steel and iron related pay items, materials, products, and components as specified on the MDOT website. MDOT will maintain a list of these pay items, materials, products, and/or components on the following website:

MDOT Buy America Step Cert List for February 2022.xlsx (michigan.gov)

Raw materials are not required to meet BA; however, every step from melting through coating application and anything else is subject to meet BA. If a steel or iron component has any step performed by a non-domestic supplier, then the total cost for the entire component would need to be less than the allowable foreign limit in order to be incorporated into the project.

6.3 Foreign Steel or Iron

It is the Contractor's responsibility to seek approval from the Engineer to use foreign steel or iron prior to incorporation into the project. Additionally, it is the Contractor's responsibility to keep track of the amount of foreign steel or iron used on the project.

For additional information on BA requirements, please refer to any project specific Special Provision for Source of Steel and Iron (BA), MDOT Construction Manual, MDOT MQAP Manual, and the FHWA website.

6.4 Documentation Requirements

The Contractor is required to provide BA certification for the project and BA step certification for all products and materials not designated as full compliant with the BA requirements on the QPL, Approved Manufacturer's, and Tested Stock Suppliers List maintained by MDOT's Construction Field Services Division.

BA certification letter or Bill of Lading must include the following language:

- Supplier name
- Signature of supplier representative
- Following statement

I, (***supplier representative***), certify that the material shipped/provided to the project are in full compliance with the Federal Highway Administration (FHWA) BA requirements as specified in Title 23 of the Federal Code of Regulations (CFR) section 635.410.

BA step certification letter must include the following language:

- Supplier name
- Signature of supplier representative

- Following statement:

  I, (***supplier representative***), certify that the (***cutting, bending, punching, drilling, shearing, machining, welding, galvanizing, coating***) process/es, as specified in the purchase order, for manufacturing or fabricating the material shipped/provided to the project are in full compliance with the Federal Highway Administration (FHWA) BA requirements as specified in Title 23 of the Federal Code of Regulations (CFR) section 635.410.

Mills and manufacturing plants that produce hot-rolled shapes, hollow structural sections (HSS), plate, ingot, slab, billet, bloom, high-strength bolts, anchor bolts, prestressing strand, bar reinforcement, and welded wire reinforcement are not required to provide the above stated BA step certification letter. Instead, language located in the material test report (MTR) stating the material was melted and manufactured in the United States is sufficient to meet BA step certification requirements.

Contractors are not permitted to write BA step certification letters for their subcontractors since they do not have control over the work. This was determined based on discussions between MDOT management and FHWA.

6.5 BA Tables

Below are several tables displaying common steel and iron components used in the fabrication of structural precast concrete and structural steel elements. This information has been prepared exclusively for SFU to assist with the BA requirements. These tables are not complete and do not relieve the contractor of their contractual obligations to meet BA requirements for MDOT projects.

Table 1. Steel components used in fabricating structural precast (prestressed and non-prestressed) concrete elements.

STRUCTURAL PRECAST CONCRETE FABRICATION				
Component	Description	BA Cert	BA Step Cert	Comment
Prestressing Strand	High strength strand for prestressing concrete	Yes	*Yes	Project BA cert from fabricator and language in MTR (e.g., melted and manufactured in the USA)
Bar Reinforcement	Mild bar reinforcement for strengthening concrete	Yes	*Yes	Project BA cert from fabricator and language in MTR (e.g., melted and manufactured in the USA)
Welded Wire Fabric	Mild fabric reinforcement for strengthening concrete	Yes	*Yes	Project BA cert from fabricator and language in MTR (e.g., melted and manufactured in the USA)
Sole Plates	Steel plate cast over support and bears on the elastomeric pad	Yes	Yes	Project BA cert from fabricator and BA step certs from each supplier that performs a process

Table 1 (continued). Steel components used in fabricating structural precast (prestressed and non-prestressed) concrete elements.

STRUCTURAL PRECAST CONCRETE FABRICATION				
Component	Description	BA Cert	BA Step Cert	Comment
Position Dowels	Dowels used to provide translation restraint for beams	Yes	Yes	Project BA cert from fabricator and BA step certs from each supplier that performs a process
MSE Connection Lug	Connects wall panel to reinforcement	Yes	No	Project BA cert from fabricator
Laminated Elastomeric Pad	Steel shims used to reinforce elastomeric pads	Yes	Yes	Project BA cert from fabricator and BA step certs from each supplier that performs a process
PCI Beam Lifting Strand	Device for moving beams	Yes	No	Project BA cert from fabricator
Culvert Lifting Device	Device for moving culverts	Yes	No	Project BA cert from fabricator
MSEW Lifting Device	Device for moving MSEW panels, posts, and copings	Yes	No	Project BA cert from fabricator
Sound Wall Lifting Device	Device for moving sound wall panels and posts	Yes	No	Project BA cert from fabricator

Table 1 (continued). Steel components used in fabricating structural precast (prestressed and non-prestressed) concrete elements.

STRUCTURAL PRECAST CONCRETE FABRICATION				
Component	Description	BA Cert	BA Step Cert	Comment
Tie Wire	Secures bar reinforcement	Yes	No	Project BA cert from fabricator
Bar Chair	Supports bar reinforcement	Yes	No	Project BA cert from fabricator
Screed Supporting Frame (pipe)	Supports screed machine	Yes	No	Project BA cert from fabricator
SIP Deck Clip	Support location for attaching SIP decking	Yes	No	Project BA cert from fabricator
Half Hanger Anchor	Supports false work	Yes	No	Project BA cert from fabricator
False Work Insert	Supports false work	Yes	No	Project BA cert from fabricator
Safety Line Embed	Provides tie off	Yes	No	Project BA cert from fabricator
Spun Pole Structural Steel	Mounts cameras, etc. to pole	Yes	No	Project BA cert from fabricator
Spun Pole Hardware	Mounts cameras, etc. to pole	Yes	No	Project BA cert from fabricator
Concrete Insert	Attach threaded bar reinforcement or bolt	Yes	No	Project BA cert from fabricator

* Denotes alternate BA step certification. These components do not require a BA step certification letter but do require the MTR to denote the material was melted and manufactured in the United States.

Table 2. Steel components used in fabricating steel bridge and structural steel elements.

BRIDGE STEEL AND STRUCTURAL STEEL FABRICATION				
Component	Description	BA Cert	BA Step Cert	Comment
Hot Rolled Shape and Plate	Structural steel used for fabrication of bridge or highway elements	Yes	Yes	Project BA cert from fabricator and BA step certs from each supplier that performs a process
HSS	Structural steel used for fabrication of bridge or highway elements	Yes	Yes	Project BA cert from fabricator and BA step certs from each supplier that performs a process
High Strength Bolts	Bolts for structural steel connections	Yes	*Yes	Project BA cert from fabricator and language in MTR (e.g., melted and manufactured in the USA)
Anchor Bolts	Bolts for anchoring structural elements	Yes	*Yes	Project BA cert from fabricator and language in MTR (e.g., melted and manufactured in the USA)
Laminated Elastomeric Pad	Steel shims used to reinforce elastomeric pads	Yes	Yes	Project BA cert from fabricator and BA step certs from each supplier that performs a process
Welding Rod	Weld metal used in SMAW process	Yes	No	Project BA cert from fabricator
Welding Wire	Weld metal used in GMAW, SAW, or FCAW processes	Yes	No	Project BA cert from fabricator

* Denotes alternate BA step certification. These components do not require a BA step certification letter but do require the MTR to denote the material was melted and manufactured in the United States.

7 Request for Information Process

The purpose of this section is to provide MDOT with statewide consistency managing and responding to a structural fabrication RFI. The SFU is responsible for implementing MDOT's QA for structural elements that are required to be accepted based on "Fabrication Inspection" per the MQAP manual or other contract documents. Consultant QAI's are utilized by the SFU to provide shop inspection of these fabricated and manufactured products. When information is requested, it is important for MDOT to quickly respond to an RFI submittal to keep the project moving forward. This section is broken down into the following subsections:

1. Request for Information
2. RFI Report
3. RFI Submittal Process
4. Innovative Contracting

7.1 Request for Information

Request for information is defined to be a request by the Supplier seeking additional information or proposing an alternate design, material, fabrication method, or inspection method for the structural element. The Supplier typically generates RFI submittals before shop drawings are produced, but they are sometimes submitted after fabrication has begun. An RFI submittal is not to be confused with an NCR that describes a nonconformance due to an alteration (material or workmanship) in the work that results in the materials or fabricated element not meeting project specifications. An NCR renders the affected element unacceptable until such time as the NCR is approved by the Engineer and the correction is found to be acceptable. Each unique RFI should be submitted on a separate form for housekeeping purposes and to speed up the response time, though this is not mandatory.

The SFU is responsible for coordinating the RFI review process and should provide a timely response or acknowledgement (explanation, decision, request for additional information, or estimate of time needed to evaluate) **within three business days** after receiving the RFI submittal. The SFU will distribute all RFIs that are design related to the Design PM for their disposition and then the Design PM is responsible for engaging other MDOT areas (Geometrics, Load Rating, Roadside Development, etc.) as applicable. MDOT will consider alternate fabrication methods or configurations, materials, or inspection procedures proposed by the Supplier provided the alternative will result in equaling or improving the expected performance, maintenance, and longevity of the structure; however, approval of an RFI may be contingent on a reduction in the contract unit price. Approved RFIs that result in contract modifications due to Supplier proposed changes (alternate material, fabrication method, inspection method, etc.) will not result in additional payment and/or time extension by MDOT. Approved RFIs that result in contract corrections due to contract errors and/or omissions may result in additional payment and/or time extension by MDOT. RFIs are resolved after they have been responded to by the SFU on the RFI form.

7.2 RFI Report

MDOT has developed a standard *Request for Information (Form 0558)* form that should be used by the Supplier. Use of the form is recommended to facilitate a faster review process. RFIs submitted on the Supplier's form are required to include, at a minimum, the following information:

1. Follow MDOT's file naming convention as shown on the RFI form.
2. MDOT project information (MDOT ID, job number, project location, and element mark).
3. RFI number in ascending order for each project (resubmittals use a different RFI number).

4. Clearly state what information is being requested or what is being proposed.
5. Clearly state the required specifications if an alternate is being proposed.
6. Include drawings (contract plan, sketches, etc.), numerous high-resolution photos, product data sheets, etc.
7. Indicate the urgency of a reply.

Approval of an RFI does not waive the contractual requirement to provide accurate shop drawings prior to the start of fabrication and is not sufficient information for the QAI to stamp elements approved for use. If the Supplier elects to use an approved RFI then they need to incorporate the RFI into the shop drawings for MDOT's review and approval prior to the start of fabrication. MDOT's QAI is instructed to inspect using approved shop drawings and approved NCRs only. The Supplier is also required to obtain the Contractor's acceptance of any contract modifications that alter the finished product.

7.3 RFI Submittal Process

Listed below is MDOT's structural fabrication RFI submittal process:

1. Supplier names RFI file per MDOT's file naming convention shown on *MDOT Form 0558*.
2. Supplier must send RFI to the SFU and carbon copy the Engineer and Contractor. All correspondence to the SFU must be sent using the following email resource unless alternate arrangements have been made:
   - MDOT-StructuralFabrication@michigan.gov
3. SFU distributes RFI to Design PM (if applicable) and begins reviewing.
4. Design PM distributes RFI to other areas (e.g., Geometrics, Load Rating, Roadside Development, etc.) as applicable, and provides all comments to SFU.
5. SFU electronically signs RFI to document who responded to the RFI.
6. SFU provides response on RFI form via email to Supplier and carbon copies the Engineer, Contractor, Design PM, and QAI.
7. SFU places RFI form into the project's "MDOT In Box" folder located in ProjectWise for historical record.

7.4 Innovative Contracting

The RFI process described above applies to Design-Bid-Build (DBB) projects. This subsection will discuss subtle changes required to successfully process RFIs for innovative contracting such as Design-Build (DB) projects.

DB is an innovative construction method that pairs the Engineer of Record (EOR) with the Contractor. The main difference between a DB and a DBB project is that the EOR on the DB team is required to completely review and approve the RFI submittal prior to MDOT's review. One method for processing DB RFIs is shown below, but it is important to note that each DB project requires a discussion of the actual RFI process to be used for that project and it should begin internally prior to the prefabrication meeting and be discussed at the meeting.

Once the DB team is satisfied with the submittal, the MDOT DB PM acts as the MDOT RFI coordinator and distributes the submittal to the SFU for review. The SFU returns any comments to the DB PM. Once satisfied, the SFU electronically signs the RFI form. The DB PM must be included on all correspondence related to an RFI, therefore subsection 7.3 must be revised to reflect this for DB projects.

8 Nonconformance Process

The purpose of this section is to provide MDOT with statewide consistency managing and responding to structural fabrication NCRs. The SFU is responsible for implementing MDOT's QA program for structural elements required to be accepted based on "Fabrication Inspection" per the MQAP manual or other contract documents. Consultant QAIs are utilized by the SFU to provide shop inspection of these fabricated and manufactured products. When an NCR is submitted, it is important for the SFU to respond quickly to keep the project moving forward. This section is broken down into the following subsections:

1. Nonconformance
2. QC Nonconformance Report
3. QA Nonconformance Report
4. NCR Submittal Process
5. MDOT Standard Repair Procedures
6. Innovative Contracting

8.1 Nonconformance

Nonconformance is defined to be an alteration (material or workmanship) in the work that results in the materials or fabricated product not meeting project specifications and renders the piece unacceptable until such time as the NCR is approved by the Engineer and the correction is found to be acceptable. An NCR is not to be confused with an RFI that is defined to be a request by the Supplier seeking additional information or proposing an alternate material, fabrication method, or inspection method for the product. An RFI is typically submitted during shop detail drawing development (before fabrication or manufacturing work begins) seeking clarification or permission, whereas an NCR is submitted after a nonconformance has been identified by the Fabricator and includes a description of the nonconformance, Fabricator's proposed correction, and may trigger a CAR (per the Fabricator's internal CAR program or requested by the SFU).

Correction is an action to eliminate a detected nonconformity and could include determining and executing a specific disposition (use as-is, rework, scrap, or repair) or restoring a process to within control limits. Fabricators are not required to submit an NCR to MDOT when they intend to scrap the material or fabricated element; however, they are required to follow their internal nonconformance program which may require an internal NCR. When the Fabricator scraps an element, the SFU requests QC to send the QAI written correspondence that clearly documents who rejected the element, why it was rejected, when it was rejected, and proposed changes to the piece mark naming convention for the remake.

Corrective action is an action to eliminate the cause of the detected nonconformity or other undesirable situation such as a repetitive process control issue, a severe or repetitive procedural violation, a severe customer complaint, or any internal or external audit finding. This "action" includes identifying the extent of the nonconformity (quantity of affected product or materials, number of affected machines or instruments, etc.), containing the extent (like segregating, process interruption, personnel stand-down, etc.), correcting the nonconformity (see correction above), identifying the root cause, and implementing long-term verifiable action to prevent recurrence. CARs may be triggered by the Fabricator's internal CAR program or requested by the SFU for the above stated reasons. It is important to note that repetitive nonconformances on one project may not trigger a CAR, but similar nonconformances for a different project may result in a severe complaint from the Engineer resulting in a CAR due to the sensitive nature of one project over another.

MDOT categorizes nonconformances as ***minor*** or ***major***. Minor nonconformances do not require an NCR to be submitted to MDOT for review and approval; however, the Fabricator's repair procedure is required to be reviewed and approved by MDOT. Fabricators are encouraged to submit these repair procedures early in the project for preapproval and to make them non-project specific so they can be blanket approved for all MDOT projects and effective indefinitely until such time as the procedure needs to be updated and the blanket approval has been rescinded by the SFU. The Fabricator may submit one of *MDOT's Standard Structural Precast Concrete Repair Procedures* or may be the Fabricator's own procedure; however, the procedure must include limits of application. Major nonconformances do require an NCR to be submitted to the SFU for review and approval.

Below are examples of minor nonconformances that can be preapproved by the SFU provided limits of application are included:

1. Industry standard coating repairs
2. Concrete air hole and minor surface defects
3. Weld repairs not requiring Engineer's approval
4. Epoxy coating damage
5. HDG damage

Below are examples of major nonconformances that require approval of an NCR:

1. BA documentation deficiencies
2. Material deficiencies
3. Dimensional tolerances
4. Unauthorized repairs
5. Non-standard coating defects (determined by Engineer)
6. Unauthorized welds
7. Weld repairs requiring Engineer's approval (i.e., critical FCM repairs)
8. Weld repairs found by QA after QC has approved the weld
9. Welder, tack welder, or welding operator qualification deficiencies
10. WPS related deficiencies
11. Concrete fresh properties outside specification limits
12. Concrete compressive strength below specification limit
13. Concrete curing deficiencies
14. Concrete honeycombing, voids, and damage (except minor surface defects)

The QAI should obtain clarification from the SFU if there are questions regarding the nonconformance category. All nonconformance issues observed by the QAI must be brought to the attention of the Fabricator's QCI immediately upon discovery; however, the QAI must perform their due diligence to verify the finding is nonconforming prior to notifying the QCI. QAI must not direct correction nor corrective action but may be helpful by sharing general conformance information. The QAI must notify the SFU immediately if the Fabricator continues to fabricate nonconforming elements.

Verbally notifying the Fabricator of nonconformance is sometimes sufficient; however, critical nonconformances and disagreements between the QAI and QCI whether a finding is a nonconformance should always be followed up in writing. The SFU will decide if the Fabricator's operations warrant notifying the Engineer and Design PM to prevent schedule delays or potential claims. An internal conference call amongst the SFU Unit, Engineer, Design PM, and QAI may be needed to better understand the issue and to discuss *MDOT's Structural Fabrication Nonconformance Policy* to ensure statewide consistency with acceptance of nonconforming materials and potential price reductions if nonconforming elements are permitted to be incorporated into the project.

The SFU is responsible for coordinating MDOTs NCR review process and should provide a timely response or acknowledgement (explanation, decision, request for additional information, or estimate of time needed to evaluate) **within three business days** after receiving the NCR submittal. SFU will distribute all NCRs that are design related to the Design PM for their disposition. The Design PM is responsible for engaging other MDOT areas (Geometrics, Load Rating, Roadside Development, etc.) as applicable to provide their design response. All NCRs are required to be stamped "Approved" by the SFU if they are found to be acceptable to MDOT. Unacceptable NCRs are returned to the Contractor with an appropriate response and stamped "Not Approved". Correction that requires use of a WPS will require the SFU to review and approve the WPS in addition to the NCR.

8.2 QC Nonconformance Report

QC NCRs are generated by the Fabricator after their QCI observes a nonconformance during their inspection. The Fabricator is required to submit the NCR to MDOT as discussed in subsection 8.4 if they intend to have the element considered by MDOT to be incorporated into the project. Although not required, it is highly recommended that the QCI discuss the NCR submittal with the QAI to ensure it is in general conformance with MDOT requirements. The QAI should not review the actual NCR now since they will be asked to verify that the NCR is accurate by the SFU after the Contractor submits it to MDOT. Fabricators are expected to generate and track nonconformances in accordance with their internal NCR program in the event the nonconformance does not warrant an NCR by MDOT.MDOT has developed a standard *Nonconformance Report (Form 0559)* form that should be used by the Supplier. Use of the form is recommended to facilitate a faster review process. NCRs submitted on the Supplier's form are required to include, at a minimum, the following information:

1. Follow MDOT's file naming convention as shown on the NCR form.
2. MDOT project information (MDOT ID, job number, project location, and element mark).
3. NCR number in ascending order for each project (resubmittals use the same NCR number but would have a different revision number).
4. Clearly describe the nonconformance.
5. Proposed correction.
6. Include supporting documentation (marked up shop drawings, QC reports, WPS, PQR, numerous high-resolution photos showing all locations proposed to be repaired, etc.).
7. Include the Fabricator's internal CAR number if applicable. If the NCR was not discussed with the SFU prior to submittal and corrective action is requested, then the SFU will contact the Fabricator to obtain a CAR number from them.
8. Indicate the urgency of a reply.

Fabricator must notify the QAI and provide them with a reasonable opportunity to observe all repairs. Elements containing repairs performed without adequate notification to the QAI may not be approved for use or may require re-work. All nonconformances must be properly resolved before the element can be considered for acceptance and approved for shipping.

8.3 QA Nonconformance Report

It is not common for MDOT to write an NCR; however, a QA NCR could be issued due to one of the following reasons:

1. Fabricator disagrees material or workmanship is nonconforming.
2. Ineffective QC resulting in QAI finding repeated major nonconformances after QC has completed their inspection.

SFU uses the standard *Quality Assurance Nonconformance Report (Form 0560)* for a QA NCR and submits the completed form to the Engineer and Design PM for their review and subsequent discussion. It is important for QA to document when QC is ineffective so SFU can discuss the concerns with the Fabricator and share with the plant certification company (ACPA, AISC, NPCA, and PCI) on an as needed basis. The Fabricator is required to respond to the QA NCR by either submitting their own NCR addressing the nonconformance or in writing that they disagree. A conference call may be requested by the SFU between the Engineer, QAI, Contractor, Fabricator, and QCI to discuss the NCR.

Once all pieces have been re-inspected by the QCI, they must notify the QAI via email or by submittal of the QC report that the QC inspection is complete for the pieces under consideration. The QAI will start the QA verification inspection again and if nonconformances are found then the process will repeat itself. It is important to note that the QAI must not perform their QA verification inspection until after the QCI notifies them via email or by submittal of the QC report that their QC inspection is complete for the elements under consideration.

8.4 NCR Submittal Process

Listed below is MDOT's structural fabrication NCR submittal process:

1. Fabricator names NCR file per MDOT's file naming convention shown on *MDOT Form 0559*.
2. Fabricator must send NCR to the SFU, and carbon copy the Engineer and Contractor. All correspondence to the SFU must be sent using the following email resource unless alternate arrangements have been made:
    - MDOT-StructuralFabrication@michigan.gov
3. SFU distributes NCR to QAI and Design PM (if applicable) and begins reviewing.
4. Design PM distributes NCR to other areas (e.g., Geometrics, Load Rating, Roadside Development, etc.) as applicable, and provides all comments to the SFU.
5. SFU provides response on NCR via email to Fabricator and carbon copies the Engineer, Contractor, Design PM, and QAI.
6. QAI places NCR and correspondence in the fabrication inspection file that will be stored in ProjectWise.

8.5 MDOT Standard Repair Procedures

The SFU has developed standard repair procedures to expedite the review process for common repairs to structural elements. These repair procedures have been reviewed by industry and should be used by Fabricators when applicable to speed up the review process. Standard repair procedures for structural steel have not been developed at this time but will be added in subsequent revisions. Listed below are the MDOT standard structural precast concrete repair procedures, which can be found in Appendix A4:

1. *Procedure #1: Air Hole
2. **Procedure #2: Minor Surface Defect
3. Procedure #3: Major Surface Defect
4. *Procedure #4: Hot-Dip Galvanize
5. Procedure #5: Fiber Reinforced Polymer
6. *Procedure #6: Epoxy Bar
7. Procedure #7: Epoxy Injection

* Indicates MDOT standard repair procedure for minor nonconformance. These procedures can be preapproved by the SFU before the project begins and are effective until the standard repair procedure is revised. Fabricator is required to notify the QAI when the repairs will be performed so they can have the opportunity to observe and must always have copies of the standard repair plan with them while performing the repair.

** Indicates MDOT standard repair procedure that requires the Fabricator to include limits of application for product(s) being repaired for SFU approval prior to use. Non-project specific blanket approval is recommended.

8.6 Innovative Contracting

The nonconformance reporting process described above applies to DBB projects. This subsection will discuss subtle changes required to successfully process NCRs for innovative contracting such as DB projects. Fabrication nonconformance should already be addressed in the DB Design Quality Manual (DQM); however, *MDOT's Structural Fabrication Nonconformance Policy* provides MDOT with statewide consistency in addressing material and fabrication nonconformance issues.

DB is an innovative construction method that pairs the EOR with the Contractor. The main difference between a DB and a DBB project is that the EOR on the DB team is required to completely review and approve the NCR submittal prior to MDOT's review. One method for processing DB NCRs is shown below, but it is important to note that each DB project requires a discussion of the actual NCR process to be used for that project and it should begin internally prior to the prefabrication meeting and be discussed at the meeting.

Standard DB NCR Process: Once the DB team is satisfied with the submittal, the MDOT DB PM acts as the MDOT NCR coordinator and distributes the submittal to the SFU for review. The SFU returns any comments to the DB PM. If satisfied, the SFU stamps "**Approved**" on the NCR. The DB PM must be included on all correspondence related to an NCR; therefore subsection 8.4 (NCR Submittal Process) must be revised to reflect this.

9 Nonconformance Policy

The purpose of this section is to provide MDOT with statewide consistency in addressing whether structural fabrication nonconformances that are inspected by the SFU may be incorporated into the project and if a price reduction is warranted. The SFU is responsible for implementing MDOT's QA program for material required to be accepted based on "Fabrication Inspection" per the MQAP manual or other contract documents. The Engineer is responsible for rejecting or accepting nonconformances; however, the SFU responds to most nonconformances on behalf of the Engineer. Additionally, the Engineer is responsible for considering and imposing a price reduction in accordance with subsection 104.04 of the SSC. Guidelines specific to structural fabrication are provided in this section for the Engineer and SFU to use when determining if a price reduction is warranted. When a price reduction is warranted, the SFU provides the recommended amount to ensure statewide consistency and alignment; however, it is ultimately the Engineer's decision.

9.1 Control of Materials

The service life of a highway system is dependent upon the quality of the materials and the method in which those materials are constructed (fabricated, manufactured, produced, galvanized, etc.); therefore, it is critical to ensure the supplied materials incorporated into the work meet the project specifications. Control of materials is discussed in subsection 105 of the SSC with information on approval of materials in subsection 105.05 and nonconforming materials in subsection 105.08. The Engineer may inspect all materials that the Contractor will incorporate into the work at any time and at any place during the preparation, storage, and use of the material. In addition, the Engineer may perform inspections of the materials, including sampling and testing, in accordance with the methods required by the contract to determine if the material is approved for use. Material approval is discussed in MDOT's MQAP.

9.2 Nonconforming Materials

It is MDOT's intent to discourage the use of nonconforming materials from being incorporated into the work even if they are found acceptable for use. Subsection 105.08 of the SSC gives the Engineer the authority to either reject nonconforming materials or to allow the nonconforming materials to remain in place. If materials are found to be unacceptable before or after placement into the work, the Engineer may reject the materials and the Contractor must remove the materials from the site at no cost to MDOT. Materials that have been tested and approved at their source or otherwise previously approved but have become damaged or contaminated before use in the project are also subject to rejection by the Engineer.

Materials that are nonconforming but determined by the Engineer to be acceptable for use may be subject to a price reduction. To ensure consistency in the decisions made for acceptance of nonconforming material or workmanship, it is recommended the Engineer involve SFU before finalizing any decision. This communication will aid in the consistent treatment of nonconforming materials statewide. The SFU is available to provide technical support if the Engineer has any questions regarding the acceptance or rejection of nonconforming materials. It is the Engineer's responsibility to determine whether a nonconforming material is acceptable for use; however, the SFU can assist with recommendations.

9.2.1 Determining if Nonconforming Material can be Incorporated into the Work

Good engineering judgment is required when making decisions on nonconforming materials. The Engineer may choose to approve nonconforming materials, allow them to be incorporated into the work, and impose a price reduction. When making the decision to direct the Contractor to remove and replace the materials versus leave the materials in place, it is important to consider the following:

1. Safety.
2. Long-term consequences on quality and durability.
3. Implications on the structural element's life cycle costs, service life, serviceability, and maintenance.
4. Environmental and aesthetic considerations.
5. Impacts on the project's traffic, staging, and construction timeframes.
6. Future costs associated with maintenance.

9.3 Determination of Price Reductions

After the Engineer has decided to allow nonconforming materials to remain in place, the SFU will carefully evaluate each situation in deciding whether to recommend a price reduction. The goal is to achieve statewide consistency in administering price reductions for nonconforming materials allowed to remain place. The purpose of the price reduction is to facilitate an environment that encourages the Contractor to incorporate materials meeting contract specifications making it fair for all contractors.

Results of retests and related quality tests should be considered. The following list includes some examples of the types of factors the SFU will consider when deciding if a price reduction is warranted:

1. Has the Fabricator been conscientious to provide quality by carefully controlling materials and construction operations?
2. Has the Fabricator been proactive and made good use of QC data to maintain and improve quality?
3. Did the Fabricator notify the SFU of materials that needed to be tested in a timely manner to ensure the test results would be reported prior to the materials being incorporated?
4. Did the SFU process the test results within the industry accepted timeframe so the Fabricator could make process or material corrections?
5. Upon becoming aware of a material quality problem, has the Fabricator responded quickly to eliminate the root cause? Including the following actions:
    a. Identifying the extent of the nonconformity (quantity of affected product or materials, number of affected machines or instruments, etc.).
    b. Containing the nonconformity (like segregating, process interruption, personnel stand-down, etc.).
    c. Correcting the nonconformity.
    d. Identifying the root cause.
    e. Implementing long-term verifiable action to prevent recurrence.
6. Is the nonconforming test an isolated incident or a recurring situation?
7. How does the nonconforming test compare to the rest of the project data:
    a. Have material test results been well within specification requirements or consistently at the very limit of what is acceptable?
    b. How many tests are nonconforming versus how many tests have passed?
    c. How far out of specifications is the nonconforming test?

9.4 Nonconforming Structural Precast Concrete

If the Engineer has decided to accept nonconforming material and it is determined that a price reduction is warranted, then the final step is for the SFU to provide a recommended price reduction. The following guidelines provide a list of common nonconformance issues related to the structural precast (prestressed and non-prestressed) concrete industry and are intended to aid the SFU in determining the recommended price reduction. The goal of these guidelines is to provide consistent price reductions; however, each project is unique and what may be inconsequential or have a minimal impact on one project may have a much larger impact on another.

The Engineer must justify and document the incorporation of any nonconforming materials into the work. The SFU will provide the Engineer with the quantity and type of nonconforming material for the project office's records. Only one price reduction should be applied to a given quantity of material; however, if multiple nonconformance issues occur then the price reduction may be increased on a case-by-case basis. In general, if the quantity in question is subject to more than one of the following price reductions then the greater price reduction would apply.

Any structural precast concrete element judged to be structurally or otherwise unacceptable by MDOT due to low strength, cracking, breakage, honeycombing, excessive repairs, or other deficiency will be rejected and replaced. Note that honeycombing with exposed prestressing strand automatically falls into this category.

Any structural precast concrete element judged to be acceptable, but deficient by MDOT due to any of the following issues will be subject to the price deductions listed below. These guidelines for standard deductions are intended to be applied to typical problem severity for most cases. In occasional cases where problem severity is lower or higher than typical, the pay deduction may be decreased or increased, respectively. Standard deductions shown represent a percentage of bid item price for the structural precast concrete element.

9.4.1 Compressive Strength

Compressive strength below specified level at required test age for strand release, stripping forms, shipping, etc. is subject to the greater of $500 or 20 percent deduction on the bid item price if the elements are approved for use. This price reduction would apply for all elements represented by the strength test.

9.4.2 Fabrication Defects

Price reduction for the following fabrication defects and nonconformances will be recommended by the SFU and should be implemented by the Engineer. The following list of deductions will be applied to infrequent occurrences of the stated defects. In the event of repeated occurrences of the same defect, these deductions will be **doubled**. Price reductions may be waived for nonconformances judged to be inconsequential.

The following price reduction percentages are deducted from the bid item price and are only applicable to nonconforming structural precast concrete elements determined by the Engineer to be acceptable:

1. Misalignment of form and soffit joints (1/8 inch or greater on flat surface) – 10 percent price reduction.
2. Inadequately sealed joints with significant mortar washout – 10 percent priced reduction.
3. Cracking/spalling caused by fabrication and curing – 10 percent price reduction.
4. Dimensional tolerance deviations outside contract documents – 10 percent price reduction.
5. Honeycombing – 10 percent price reduction.

6. *Curing temperature – 10 percent price reduction.
7. Broken/cracked components – 10 percent price reduction.

*** Concrete elements cured at elevated temperatures are suspect in terms of durability. The SFU will make a recommendation to the Engineer to either reject the element or accept it with a price reduction.**

9.4.3 Miscellaneous Topics

The Engineer must determine the quantity of nonconforming material. Only one price reduction will be applied to a given quantity of material. If the quantity in question is subject to more than one of the following conditions, apply the adjustment with the greater price reduction.

If the structural element does not conform to the requirements of the contract, but is accepted, apply one of the following two price reductions (if not already covered in part 9.4.1 or 9.4.2):

1. 20 percent price reduction on the bid item price.
2. 50 percent price reduction on **all** material (invoice) costs utilized to fabricate the structural precast concrete element.

The Engineer should not pay for elements determined by the Engineer to be safe for use but due to nonconformance(s) possess significant service life concerns.

9.5 Nonconforming Bridge and Structural Steel

Due to the specialized nature and track record of structural steel fabrication, acceptable nonconformance rarely lends itself to recommended price reductions. In general, deficient structural welds can be easily replaced and the homogenous nature of steel typically means if the material does not meet specification, then it is rarely accepted even with a price reduction. However, the SFU would review and provide a recommended price reduction to the Engineer on a case-by-case basis depending on the nature of the deficiency, recurrence, etc. Dimensional tolerance deviations outside the contract documents is an example of a workmanship nonconformance subject to a 10 percent price reduction from the bid item price if the structural steel element is determined by the Engineer to be acceptable.

9.6 Special Cases

For other nonconforming issues not covered above, consult personnel in the appropriate area of the Bureau of Field Services for guidance. Examples of items in which it may be unacceptable to leave the nonconforming item in place, even at reduced cost, include the following:

- Bar Reinforcement
- Anchor Bolts
- High Strength Bolts

10 Corrective Action Request Process

The purpose of this section is to provide MDOT with statewide consistency managing and responding to structural fabrication CARs. The SFU is responsible for establishing a protocol for requesting and resolving corrective action from MDOT Fabricators, Manufacturers, and Suppliers that supply material required to be accepted based on "Fabrication Inspection" per the MQAP manual or other contract documents. The SFU and its designated shop inspection consultants review project performance, particularly nonconformities, for systemic QMS issues to determine if additional action is required beyond correction to avoid future negative impact to project quality. When corrective action is warranted, it is important for MDOT to consistently respond to prevent recurrence.

Corrective action may be requested by MDOT due to a critical nonconformance or recurring minor or major nonconformances. It is important to note that similar nonconformities occurring on different projects may have completely different project impacts (schedule, quality, aesthetics, etc.). Additionally, when, and how a nonconformance is detected also plays a significant part in determining when corrective action is warranted. For example, a nonconformance detected early in the project by QC with adequate time to properly address (correction or remake) is significantly different than a nonconformance detected in the field after the product was released by QC.

10.1 Process Steps

1. Review of nonconformance reports, quality records, and weekly shop inspection reports for systemic quality performance issues. Proceed to Step 2 if it is determined that a corrective action is required.

2. Upon determining the issue and necessary response times, SFU or its designated consultant issue a MDOT CAR to the related Fabricator, Manufacturer, or Supplier and records the issue date in the MDOT CAR log. Each CAR must contain the following:

    - Missed requirement or justification for the CAR
    - Required response date
    - Closure evidence due date

3. The CAR recipient evaluates the quality issues raised, takes immediate action to determine and contain the extent of the affected products, performs the appropriate root cause analysis, and proposes appropriate corrective actions in a formal response to the MDOT CAR within the allotted duration. Responses are recorded on the MDOT CAR and evidence of executing the corrective actions is attached to the MDOT CAR email response. MDOT receipt of the CAR response is recorded in the MDOT CAR log.

4. SFU reviews the response and replies to CAR recipients with requests for revisions (i.e., rejection) or acknowledgements that the responses are complete and appropriate. MDOT response to the CAR recipient is recorded in the MDOT CAR log. Rejection and request for revision will include a revised due date for response.

5. After an appropriate duration, as proposed and accepted in the MDOT CAR response, the CAR recipient sends closure evidence and certifies that the corrective action(s) taken have remained implemented and are effective in preventing the recurrence of the quality issue. MDOT receipt of the closure evidence is recorded in the MDOT CAR log.

6. MDOT accepts the closure evidence and closes the CAR or requests further evidence until satisfied. CAR closure is recorded in the MDOT CAR Log.

10.2 Form Requirements

MDOT has not developed a standard CAR form to be used by the Fabricator since it is a requirement of their QMS. The Fabricator CAR form is required to include, at a minimum, the following information:

1. CAR number and Revision ID/Date
2. NCR(s) represented
3. Project(s) represented
4. Job location(s)
5. Nonconformance description and missed requirement (reference and section number
6. Root cause analysis
7. Action to identify extent and contain the problem
8. Corrective action – the proposed long-term action(s) to prevent recurrence
9. Responsible Fabricator Department/Section/Unit
10. Initial response date
11. Designated respondee
12. Objective evidence required
13. Due date for evidence
14. Close out date
15. Follow up date
16. Closing remarks

10.3 Examples

A. 3rd occurrence of the same/similar major nonconformance as defined in *MDOT's Structural Fabrication Nonconformance Reporting Process*, except as noted below:

1. Any unauthorized or undocumented repair (for repairs that required documentation).
2. Any unauthorized welds.
3. Weld repairs will be reviewed on a case-by-case basis by SFU.
4. Welder qualification deficiencies will be reviewed on a case-by-case basis by SFU.
5. 2nd time concrete curing deficiency.
6. 2nd time occurrence of any unapproved material substitution or deficiencies.

B. 3rd occurrence of the same/similar minor nonconformance as defined in *MDOT's Structural Fabrication Nonconformance Reporting Process*. These will be reviewed on a case-by-case basis by SFU to ensure a CAR is only required for minor nonconformances deemed excessive or avoidable by MDOT.

1. Any structural defects not repaired or addressed prior to final/shipping inspection. Examples of these include, but are not limited to:
    - Concrete repair
    - Carbon fiber wrap
    - Drilling/coring
    - Adhesive anchoring

C. 2nd occurrence of failure to notify QAI in advance of a hold point.

D. 3rd occurrence of failure to provide documentation for an inspection within 24 hours (non-workdays do not count).

E. Structural defects found at receipt in the field.

Appendixes

Appendix A1: Fabrication Inspection Flowchart

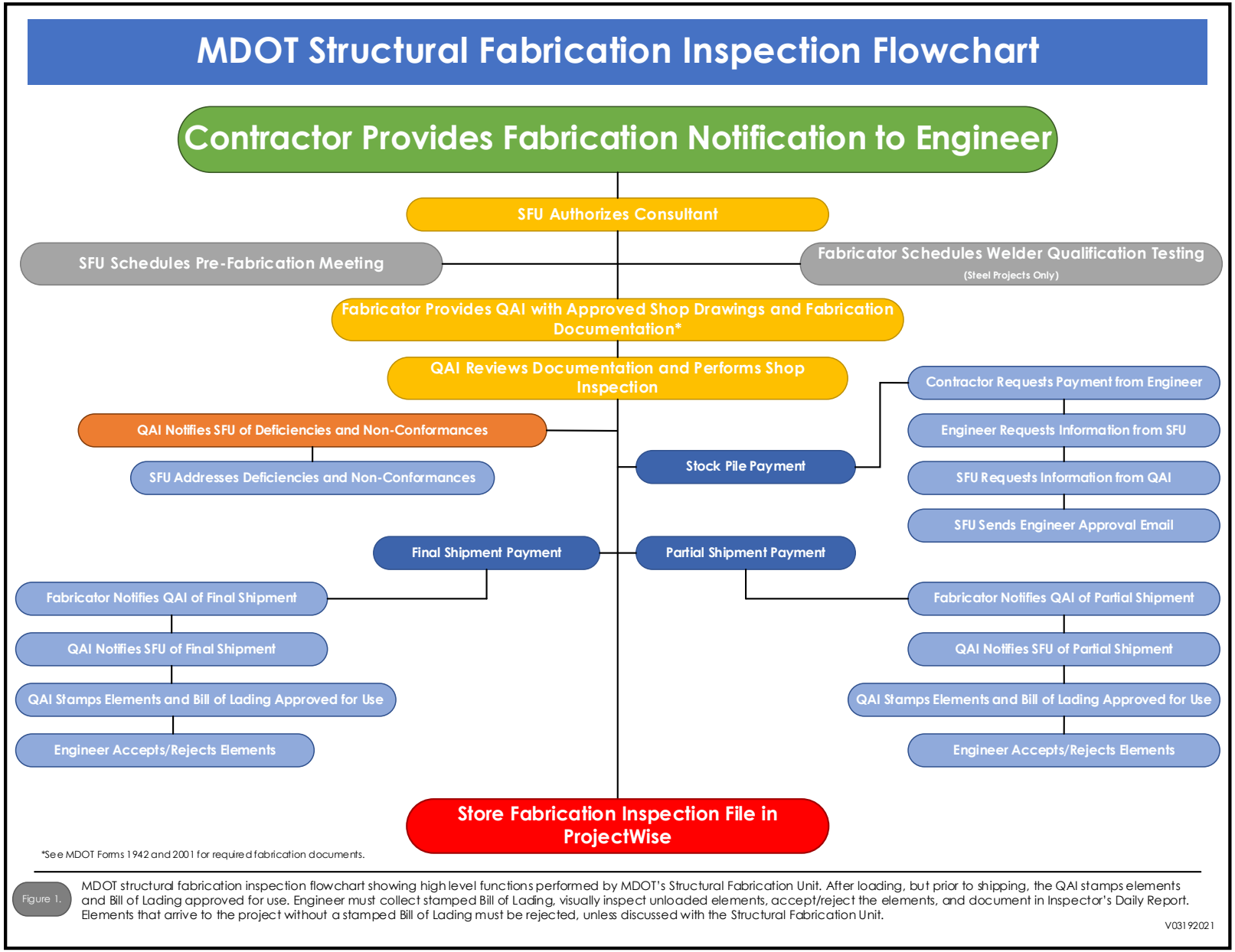

Figure 1. MDOT structural fabrication inspection flowchart showing high level functions performed by MDOT's Structural Fabrication Unit. After loading, but prior to shipping, the QAI stamps elements and Bill of Lading approved for use. Engineer must collect stamped Bill of Lading, visually inspect unloaded elements, accept/reject the elements, and document in Inspector's Daily Report. Elements that arrive to the project without a stamped Bill of Lading must be rejected, unless discussed with the Structural Fabrication Unit.

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Appendix A2: Concrete Narrative Reports

MDOT expects a minimum level of information in its QAI reports as part of its acceptance program. This section includes reporting guidelines specific to structural precast (non-prestressed or prestressed) concrete fabrication. These guidelines are in addition to the general narrative reporting requirements explained earlier in this manual; they are not all inclusive and may not be applicable to every report. Inspectors must use discretion.

Report the following information for the day, confirm acceptability, and note exceptions and deviations, as applicable. When any of the below information is recorded on a related MDOT Form and the form is completed that day, there is no need to repeat that information in the narrative report except for a reference to the related MDOT Form report number for the reported characteristic.

a. Materials accepted: specification, material name, supplier, brand name, source location, MSL yes/no, visually accepted, inspected quantity (or percentage of total for project).

b. Facility and Equipment inspection: description of areas and equipment inspected.

c. Qualified operators of equipment (stressing jacks) and certified personnel conducting stressing/elongation calculations.

d. Strand packs observed in use or staged for use: IDs.

e. Visual verification of aggregate gradation for potential contamination issues involving coarse aggregates, fine aggregates, or other deleterious materials. Large amounts of fine aggregate observed in the coarse aggregate or dirt other than sand observed in the fine aggregate.

f. List of piece marks/elements cast.

g. Casting area, stressing bed, and anchorage used: ID.

h. Steel form(s) used: element type, steel form ID(s) (if applicable).

i. Stressing jack(s) used: ID.

j. Mix design used: ID (can be listed once per week).

k. Batch tickets: IDs, note any that were adjusted in transit to casting location (specifics of adjustments not required).

l. Strength test cylinders: quantity, IDs.

m. Segregation controls: pouring technique (layered, staggered, etc.), consolidation methods used.

n. Epoxy coated reinforcement protection: tools used, other noteworthy conditions.

o. Curing controls: temperature monitoring equipment in use and status.

p. Strength test cylinders broken: report only those witnessed.

q. Strand release: method, control of sequence, distance from beam end.

r. List piece marks inspected post-pour: IDs.

s. List piece marks inspected/released for shipment: IDs.

Michigan Department
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FABRICATION INSPECTION REPORT

To be completed by the QA inspector and included in the final project documentation file.

REPORT # 1

GENERAL INFORMATION		
INSPECTION AGENCY ABC Inspection Agency	INSPECTOR John Doe	DATE 24 April 2020
FABRICATOR / LOCATION Prestress Girder Company		MDOT ID B01-222540
JOB DESCRIPTION M-25 Bridge over Buck Creek	SIZE AND ELEMENT TYPE MDOT 1800 Bulb Tee Girder	JOB NUMBER 190045CON
STATUS OF FABRICATION FOR PERIOD ENDING Week Ending 24 April 2020	REQUESTED DELIVERY DATE 30 June 2020	FABRICATED 5%

COMMENTS

20 April 2020

CONDITIONS
Air Temperature – 60/32 degrees Fahrenheit
Relative Humidity – 49%
Mostly Cloudy
Work Exposure – Work is fully exposed to elements

ACTIVITY
Travelled to Prestressed Girders' facility at Anytown USA. Arrived at the facility at 9:30AM.
I met with Joe Smith, Plant Manager, and Tom Thumb, Quality Control Manager at 10:00 AM to discuss the current schedule at the plant. Currently, the shop has all material for the first phase of the project has been received, stored per company policy and ready for production. The first phase will consist of 16 of the 32 total girders for the project.

Stranding is scheduled to begin on 22 April 2020. The shop drawings have been submitted and approved by MDOT. I requested the current calibration records and training records for the concrete testing personnel, strand tensioning staff, and PCI certifications. Tom stated that he would supply that information later today. The meeting concluded at 12:00PM.

I received the certifications from Tom Thumb and reviewed the records. All certifications are up to date. My PM (Sarah Parker) furnished a copy of the approved MDOT Form 0501 (MSL) for the material to be used on the project. I reviewed the list for verification tomorrow.

HOURS WORKED
Travel time - 2 hours
Total time at the plant - 6 hours
Hours worked on report and form preparation - 0:30 hours
Total hours worked on MDOT project - 8 hours

21 April 2020

CONDITIONS
Air Temperature – 55/33 degrees Fahrenheit
Relative Humidity - 41%
Mostly Sunny
Work Exposure – Work is fully exposed to elements

ACTIVITY
I arrived at the plant at 7:30AM. The material on MDOT Form 0501 was reviewed for conformance and verified for acceptance. The following material has been reviewed for the first phase of the project.

MDOT Material Spec.	Material Item	Supplier	Brand Name	Location	MSL	VI	Accepted
905.07	PS Strand	InSteel Wire	N/A		Yes	Yes – 100%	Yes

902.08	2NS sand	Aggregate Industries	N/A	Edwardsburg 14-026	Yes	Yes – 100%	Yes
902.03	17A Limestone	Meshberger Brothers	N/A	Pleasant Mills 92-030	Yes	Yes – 100%	Yes
901	Type III cement	Buzzi Unicem USA	N/A	Greencastle	Yes	Yes – 100%	Yes
903.02	Type F air entrainment	GCP Applied Technologies	Terapave AEA		Yes	Yes – 100%	Yes
905.03C	Reinforcing steel(coated)	Nucor Steel – Kankakee		Bourbonnais	Yes	Yes – 50%	Yes
906	Inserts	Dayton Superior	F-42 & B-1		No	Yes – 100%	Yes
906	Sole Plates	Cardinal Fab & AZZ		AZZ-Plymouth	Yes	Yes – 50%	Yes

* Values are approximate percentage of the total project quantities represented by the noted VI.

I verbally notified Joe Smith and Tom Thumb that the inserts presented for verification were not listed on the approved MSL form. I emailed Tom Thumb and copied Sarah Parker regarding the issue with the inserts and that the material hold point is released with the noted issue in accordance with the QAI ITP.
The plant began preparing Stressing Bed A1 for stranding to begin tomorrow. I inspected the side forms that will be used for the project. The forms were acceptable for use. I checked the anchorages, no unusual modifications.
I prepared independent stressing and elongation calculations.
Storage areas were in acceptable conditions. Aggregate stockpiles showed no signs of contamination or gradation issues.

HOURS WORKED
Total time at the plant -8 hours
Total time spent out in the plant - 6 hours
Hours worked on reports and calculations - 2 hours
Total hours worked on MDOT project – 8

22 April 2020

CONDITIONS
Air Temperature – 57/34 degrees Fahrenheit
Relative Humidity 56%
Cloudy - Light precipitation
Work Exposure – Work is fully exposed to elements

ACTIVITY
I arrived at the plant at 8:00AM. The plant had begun the stranding operation. Strand Packs 111 and 112 were in use. The strands were inspected for location and physical condition and the results were reported in MDOT Form 5616. I verbally released the hold point requirement for tensioning readiness in accordance with the QAI ITP after observing Tom Thumb's elongation calculations were similar to the previous day calculations for the same bed and strand configuration. The strands were tensioned to the initial stress and final stressing operations commenced, using stressing jack rig 1A. I sampled 20 percent of the strands after the bed was completely tensioned and confirmed by Tom Thumb to be properly tensioned. I verified the sampled strands met Tom Thumb's elongation calculation. The results of the strand tensioning are listed in MDOT Form 0513 with elongation measurements listed for only the strands I verified. I did a more detailed elongation calculation review after tensioning and did not have any comments.
Plant personnel commenced placing reinforcement steel and inserts. Joe Smith indicated that they plan to pour concrete at 9:00AM on 23 April 2020.

HOURS WORKED
Total time at the plant – 9 hours
Total time spent out in the plant – 8 hours
Hours worked on reports – 1 hour
Total hours worked on MDOT project – 9 hours

23 April 2020

CONDITIONS
Air Temperature – 46/28 degrees Fahrenheit

Relative Humidity – 38%
Cloudy
Work Exposure – Work is fully exposed to elements

ACTIVITY
I arrived at the plant at 6:30 AM and verified the reinforcing steel placement, concrete cover for reinforcement, form placement and preparation, and sole plate locations, for beams A1, A2, and A3. The results of the verification are listed in MDOT Form 5616. Due to overnight temperatures, the pour was delayed for one hour. Tom Thumb and I conducted side by side fresh concrete tests. Concrete batch 1111 met the JMF properties and was accepted for placement in the forms. The results of the fresh concrete tests are reported on MDOT Form 590. I verbally released the hold point to permit placement of the concrete in accordance with the QAI ITP. Concrete strength cylinders A1-1, A1-2, and A1-3 for the release verification were identified and placed next to the forms to be cured in the same manner as the beams. Cylinders A1-4, A1-5, and A1-6 for the 28-day strength tests were taken to the testing lab, identified, and placed in the water bath curing tank.
Tom Thumb indicated that due to the weather forecast for the next few days, that strand release will be postponed, and additional steam curing will be used for the pour.
Concrete was poured in a two-layer sequence using mechanical form and handheld vibrators. The top flange was broom finished, and the steam curing operation commenced. Temperature monitors appeared functional and operating normally.
During consolidation it was observed that the handheld vibrators did not have the proper protective tips required for epoxy coated reinforcing bars used in these beams. A nonconformance report was initiated by the fabricator – ref. Fabricator NCR-001.

HOURS WORKED
Total time at the plant – 7 hours
Total time spent out in the plant – 6 hours
Hours worked on reports – 1 hour
Total hours worked on MDOT projects – 7 hours

22 April 2020

CONDITIONS
Air Temperature – 61/29 degrees Fahrenheit
Relative Humidity – 86%
Snowing
Work Exposure – Work is fully exposed to elements

ACTIVITY
Due to weather conditions, no work was conducted. I travelled home for the week. Tom Thumb emailed the steam curing temperatures that were recorded for the day.

HOURS WORKED
Travel time – 3 hours (weather related)
Hours worked on reports – 1 hour
Total time worked on MDOT project – 4 hours

Appendix A3: Steel Narrative Reports

MDOT expects a minimum level of information in its QAI reports as part of its acceptance program. This section includes reporting guidelines specific to structural steel fabrication. These guidelines are in addition to the general narrative reporting requirements explained earlier in this manual; they are not all inclusive and may not be applicable to every report. Inspectors must use discretion.

Report the following information for the day, confirm acceptability, and note any exceptions or deviations, as applicable. When any of the below information is recorded on a related MDOT Form and the form is completed that day, there is no need to repeat that information in the narrative report except for a reference to the related MDOT FORM report number for the reported characteristic.

a. Materials accepted: MDOT specification number, material description, supplier, material specification and grade, source location, visually accepted, inspected quantity (or percentage of total for project).

b. Facility and Equipment inspection: description of areas and equipment inspected (cutting equipment, flux ovens, electrode ovens, welding machines, etc.).

c. Welder qualifications received: note number of welders, welder operators, and tack welders for each process.

d. Welders observed: IDs, type of welding.

e. WPSs: IDs observed in use.

f. Preheat: applied temperature, required range, weld joint(s).

g. Heat number tracking data received from QC.

h. Weld pass observation: IDs, visual appearance.

i. NDT performed by QC: operator, company, methods, weld joint(s) or report number(s).

j. Laydown and assemblies.

k. Heat straightening or curving: notification, locations, method, or report number(s).

l. List piece marks inspected/released for shipping.

Michigan Department
of Transportation
5617 (11/18)

FABRICATION INSPECTION REPORT

To be completed by the QA inspector and included in the final project documentation file.

REPORT # 1

GENERAL INFORMATION		
INSPECTION AGENCY MRED Inc.	INSPECTOR Roy Biv	DATE 17 April 2020
FABRICATOR / LOCATION Steel Bridges LLC		MDOT ID S03-111032
JOB DESCRIPTION US 81 Bridge over Running River	SIZE AND ELEMENT TYPE 54" Weathering Steel Plate Girder	JOB NUMBER 191254CON
STATUS OF FABRICATION FOR PERIOD ENDING Week Ending 17 April 2020	REQUESTED DELIVERY DATE 15 August 2020	FABRICATED 2%

COMMENTS

13 April 2020

CONDITIONS

Air Temperature – 45/33 degrees Fahrenheit
Relative Humidity – 38%
Partly Sunny
Work Exposure – Work is fully enclosed with limited exposure to elements.

ACTIVITY

Traveled to Steel Bridges' facility in Anytown USA. Arrived at the facility at 9:30AM.

I met with Joe Welder, Plant Manager, and Frank Stine, Quality Control Manager at 10:00AM in Frank's office to discuss the current schedule at the plant. Currently, the shop has all material for the project in the yard and ready for production. The project consists of 25 welded plate girders, cross frames, and end diaphragms. The plant intends to start cutting diaphragm flange material on 14 April 2020 and begin flange splicing on 16 April 2020 with a completion date of 31 July 2020. The shop drawings have been submitted and approved by MDOT and were provided to me at the meeting. I requested the current MDOT welder qualification/continuity records and approved weld procedure specifications to be used on the project. Joe stated that he would supply that information later today. The meeting concluded at 12:00PM.

I received the certifications and WPSs from Joe Welder and reviewed the information. All certifications are up to date and the WPSs have been reviewed and approved by MDOT in accordance with SSC and the MDOT SFQM with the exception of WPS 19-SAW-1G-x. I emailed Sarah Parker (MRED PM) and copied Frank Stine regarding the unapproved WPS.

Joe Welder furnished their copy of the certified mill test reports for the material to be used on the project. I reviewed the list for verification tomorrow.

HOURS WORKED

Travel time - 2 hours 30 minutes
Total time at the plant - 5 hours 30 minutes (includes report and form preparation time)
Hours worked on report and form preparation - 0:30 hours
Total hours worked on MDOT project - 8 hours

14 April 2020

CONDITIONS

Weather Conditions:
Air Temperature – 48/35 degrees Fahrenheit
Relative Humidity - 35%
Mostly Cloudy
Work Exposure – Work is fully enclosed with limited exposure to elements.

ACTIVITY

I arrived at the plant at 7:30AM. The material received by the plan was reviewed for conformance and verified for acceptance. The following material has been reviewed and the hold point for material inventory was verbally released to Frank Stine.

MDOT Material Spec.	Material Item	Supplier	AASHTO M270 Grade	Location	VI*	Accepted
906.04B	1" Plate	Nucor Yamato	50W	Tuscaloosa	Yes – 100%	Yes
906.04B	3"x3" Angle	Gerdau	50W	St. Paul, MN	Yes – 100%	Yes
906.04B	½" Plate	SSAB	50W	Bettendorf, IA	Yes – 100%	Yes
906.04B	2" Plate	Arcelor Mittal	50W	Burns Harbor	Yes – 100%	Yes
906.04B	3/8" Plate	Arcelor Mittal	50W	Burns Harbor	Yes – 100%	Yes

* Note: % value represents percent of total project quantity on hand at the facility in the inspection scope.
I reviewed the CMTRs and verified the heat numbers of the received material in the yard. The plant began cutting the angles for the diaphragms and cross frames. I visually inspected the material for dimensions and found the material in conformance with the shop drawings.

Plant equipment and facilities appear to be in working order – no notable equipment was observed out of order.

HOURS WORKED
Total time at the plant - 8 hours
Total time spent out in the plant - 6 hours
Hours worked on reports and calculations - 2 hours
Total hours worked on MDOT project – 8 hours

15 April 2020

CONDITIONS
Air Temperature – 47/36 degrees Fahrenheit
Relative Humidity 66%
Cloudy - Light precipitation
Work Exposure – Work is fully enclosed with limited exposure to elements.

ACTIVITY
I arrived at the plant at 8:00AM. The fabricator had started cutting flange material for splicing. Frank provided me with a copy of the heat numbers and the proposed piece marks the plates will be incorporated into.
I received verification from Bob Otremba that the WPS 19-SAW-1G-x has been reviewed and approved by MDOT, but the fabricator was not using the stamped WPS on the shop floor; I notified the QC Manager who resolved the issue before any welding. The angles and gusset plates for 12 each of intermediate diaphragm piece marks D1 and D2 have been tack welded and final welding has commenced using FCAW. I observed welder Don Pardo (clock stamp DP1) preheat the joints to be welded and verify preheat with a Tempil Stik. As Don welded, the machine settings were verified to the approved welding procedure that was located with the welding machine. The visual appearance of both the tack welds and the production weld passes indicates the welds should pass final VI.

HOURS WORKED
Total time at the plant – 9 hours
Total time spent out in the plant – 8 hours 30 minutes
Hours worked on reports – 30 minutes
Total hours worked on MDOT project – 9 hours

16 April 2020

CONDITIONS
Air Temperature – 46/35 degrees Fahrenheit
Relative Humidity – 38%
Cloudy
Work Exposure – Work is fully enclosed with limited exposure to elements.

ACTIVITY

The plant has cut and prepared four flanges for butt splicing. The piece marks that the flanges are to be incorporated into are B1A, B1B, B2A, and B2B.
The SAW flux ovens were verified to the proper temperature and the type of flux was confirmed to meet the specifications of the approved WPS.
I verified the joint preparation and fit up and observed welder Sam Iam (clock stamp SI2) preheat one joint and commence welding the root passes for the joint. The root passes visually appeared to indicate proper welding technique is being utilized subject to NDT.
I met with Frank Stine in his office at 1:00 PM until 2:00 PM to discuss the schedule for NDT on the joints currently in production. WERT4U Inc. will be radiographing tonight. Frank provided copies of the certifications and eye exams for the personnel who will be performing the work. The certifications and eye exams were current.
I continued to verify root pass and intermediate pass welding for the remainder of the joints to be radiographed tonight. Visual appearance remains the same as noted,
I returned this evening to witness the RT set up and shots.

HOURS WORKED
Total time at the plant – 12 hours
Total time spent out in the plant – 11 hours
Hours worked on reports – 1 hour
Total hours worked on MDOT projects – 12 hours

17 April 2020

CONDITIONS
Air Temperature – 48/29 degrees Fahrenheit
Relative Humidity – 40%
Sunny
Work Exposure – Work is fully enclosed with limited exposure to elements.

ACTIVITY
I arrived at the shop at 6:30 AM and reviewed the NDT reports. There were no rejected welds indicated in the report and as reviewed by QC. A copy of the RT reports was placed in the job file. The shop continues to cut flange and web material.

HOURS WORKED
Travel time – 2 hours 30 minutes
Hours worked on reports and reviewing NDT reports and film – 4 hours
Total time worked on MDOT project – 6 hours 30 minutes

Appendix A4: Concrete Standard Repair Program

The purpose of this guidance section is to provide the SFU with statewide consistency reviewing and approving structural precast (prestressed and non-prestressed) concrete repair submittals. It provides internal guidance for the minimum acceptable procedures to ensure a durable repair that will preserve the integrity of the fabricated structural element. MDOT uses a minimum 75-year bridge design life and any proposed repairs to the element should be consistent with the original design. The SFU is responsible for implementing MDOT's QA program for structural elements required to be accepted based on "Fabrication Inspection" per the MQAP manual and utilizes consultant inspectors to provide the shop inspection. The Fabricator is required to notify the QAI prior to performing any approved repairs to provide them with the opportunity to observe.

Structural precast concrete elements may contain defects from the fabrication process or are often damaged during formwork removal or shipping and handling. The Fabricator's QCI is required to notify the QAI of all defects/damages that occur to the elements. The Fabricator is responsible for submitting an NCR with proposed correction (repair plan) to bring the element into conformance if it is to be considered for incorporation into the project. MDOT will consider the correction and provide a response to the Fabricator in accordance with *MDOT's Structural Fabrication Nonconformance Reporting Process*. Submittal of an NCR does not guarantee approval since the defect/damage may have resulted in structural, durability, or aesthetic concerns that is not addressed by the repair plan. Repairs are not permitted to be performed until after the NCR has been approved and the QAI has been notified in a timely manner when the repair will take place. See *MDOT's Structural Fabrication Nonconformance Policy* for more information on when nonconformances can be incorporated into the project and associated price reductions. See *MDOT's Structural Fabrication Nonconformance Reporting Process* for more information on what NCR's are and how to submit them. Both of these sections are referenced above in this document.

MDOT Standard Repair Procedures

Below is a list of MDOT's standard repair procedures:

1. *Standard Structural Precast Concrete Repair Procedure #1: Air Hole
2. **Standard Structural Precast Concrete Repair Procedure #2: Minor Surface Defect
3. Standard Structural Precast Concrete Repair Procedure #3: Major Surface Defect
4. *Standard Structural Precast Concrete Repair Procedure #4: Hot-Dip Galvanize
5. Standard Structural Precast Concrete Repair Procedure #5: Fiber Reinforced Polymer System
6. *Standard Structural Precast Concrete Repair Procedure #6: Epoxy Repair
7. ***Standard Structural Precast Concrete Repair Procedure #7: Epoxy Injection

* Indicates standard structural precast concrete repair procedure that does not require submittal of an NCR for SFU approval; however, the Fabricator is required to follow these procedures and notify the QAI when the repairs will be performed to provide them with the opportunity to observe. Fabricator must always have a copy of the standard repair plans with them.

** Indicates standard structural precast concrete repair procedure that does not require submittal of an NCR for SFU approval; however, the Fabricator is required to submit limits of application (size and location) for product(s) being repaired for SFU approval prior to use. Fabricator must always have a copy of the repair procedure (standard repair plan and limits of applicability) with them.

*** Indicates standard structural precast concrete repair procedure that requires submittal of an NCR for SFU approval; however, the Fabricator may work with the SFU on defining cracks considered to be minor nonconformances that do not require submittal of an NCR and obtaining a preapproved plan. For cracks defined to be minor nonconformances, the Fabricator is required to follow the repair procedure and notify the QAI when the repairs will be performed to provide them with the opportunity to observe. Fabricator must always have a copy of the standard repair plan with them and the preapproved plan.

MDOT's Structural Precast Concrete Specialist will consult with the Structural Fabrication Engineer and other technical resource areas when repair plans fall outside the scope of the above stated standard repair procedures. The following non-standard materials/procedures have been used in various applications on past projects with success:

1. BASF MasterEmaco N400 (formerly BASF HB2 which was formerly Thoroc) for overhead structural repairs and when latex repair mixtures cannot be bird-mouthed into the formwork.
2. BASF MasterEmaco N425 (preferred) and SikaTop 123 Plus (second-best option) for non-structural applications when latex repair mixtures cannot be bird-mouthed into the formwork. Note it is rare to have a non-structural repair application.
3. Non-structural crack repair: Healer sealer is a good non-structural crack repair to effectively impede moisture intrusion and chloride penetration.
4. Sealing exposed aggregate saw cuts: Healer sealer is a good product for sealing a vertical saw cut edge and water repellent treatment being the second-best option. The best option to seal concrete with exposed aggregate that will be placed in the horizontal position and is expected to be exposed to moisture is with a two-component epoxy penetrating concrete sealer product (Polycarb – Mark 124, Master Builders – Masterseal GP, E-Bond – E-Bond 120, Conspec – Spec-seal, Tamms – Dural 333, or Unitex – Pro-Poxy 200T).
5. Coating exposed steel reinforcement: Aluminum mastic epoxy is a good coating system to protect exposed steel reinforcement. The epoxy must be from a manufacturer that is listed in MDOT's QPL (Section 915: Coating Systems for Steel Structures). The manufacturer's recommendations must be followed, except the steel must be cleaned to SSPC SP6 or better. A minimum of two coats of the aluminum mastic epoxy (see manufacturer for recommended min/max DFT) must be applied with the proper cure time between coats. An acceptable concrete repair material can then be placed over the coated steel reinforcement.

Air Hole

Figure 1. Air holes greater than 3/4" in any direction and greater than 3/8" deep.

Minor Surface Defect

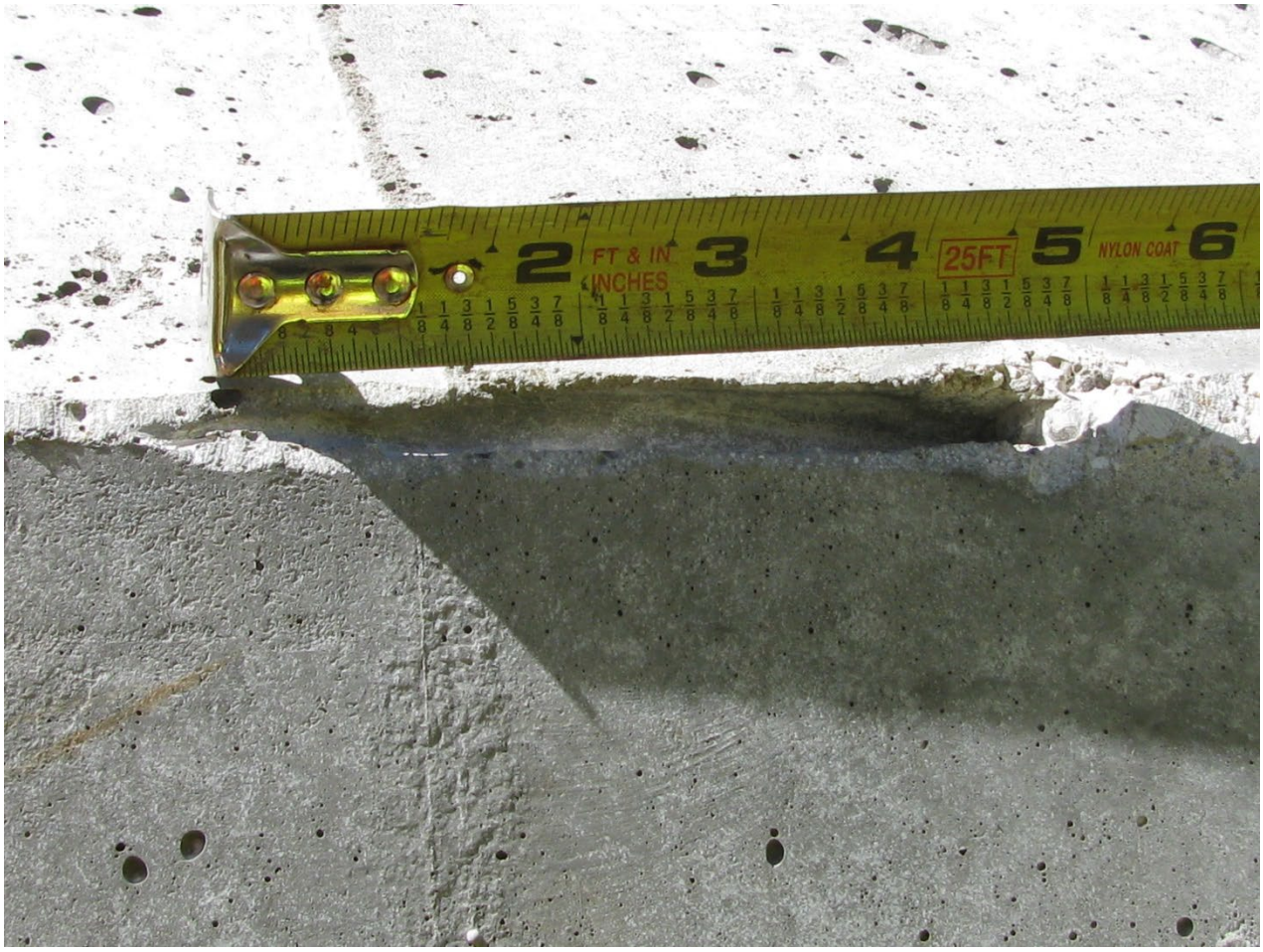

Figure 2. Rubber gasket crease

Figure 3. Moderate honeycombing along MI 1800 girder.

Figure 4. Moderate honeycombing at end of PCI beam.

Major Surface Defect

Figure 5. Broken corner at end of PCI beam.

Figure 6. Spalled bottom corner at end of box beam.

Figure 7. Spalled bottom corner at end of box beam.

Standard Structural Precast Concrete Repair Procedure #1: Air Hole

This structural precast concrete repair procedure is for patching air holes that exceed acceptable dimensional tolerances. The repair plan is in accordance with sections 406 and 708 of the 2020 Michigan Department of Transportation Standard Specifications for Construction (SSC) as applicable.

The Type R-2 mortar used for patching air holes must be selected from the following locations:

- Cement: Approved Manufacturer or Test
- White Cement: Visual inspection
- Fine aggregate (2NS or 2MS): Prequalified Aggregate Source or Test
- Air entrainment: MDOT QPL

Procedure

Below is the standard repair procedure for air holes:

1. Immediately patch all air holes larger than 3/4 inch in any direction and greater than 3/8 inch deep with Type R-2 mortar after removing forms.
2. Perform the following steps prior to patching air holes if they are not filled immediately after forms are removed:
    - Flush the area with minimum 2500 psi pressurized clean water.
    - Remove excess water from patch area by blasting with minimum 90 psi oil-free compressed air to produce a saturated surface dry condition immediately prior to application of mortar.
3. Place mortar when substrate is at least 40 degrees and rising. Maintain a temperature of at least 40 degrees Fahrenheit during the placement and curing period.

Standard Structural Precast Concrete Repair Procedure #2: Minor Surface Defect

This structural precast concrete repair plan is for minor surface defects defined to have a patch depth of less than 1.5 inches. This repair plan is in accordance with the following subsections of the 2020 SSC:

- 712.03.F.2 - Hand Chipping Concrete Other Than Deck Concrete.
- 712.03.O - Mixing, Placing, Finishing, and Curing Concrete Patches.
- 712.03.R - Cold Weather Limitations for Placing SFMC or LMC Overlay Mixtures.
- 712.03.S - Hot Weather Limitations for Placing Overlay Mixtures.

The latex bonding agent and cement used for patching mixtures must be selected from an Approved Manufacturer found in the MSG.

Procedure

Below is the standard repair procedure for minor surface defect:

1. Remove unsound or loose concrete with air hammers (15-pound class or smaller) or grinding. Saw-cut areas requiring patching to an edge depth of at least ½ inch. Patch area must have vertical edges (normal to the surface) and re-entrant corners rounded with a minimum 1-inch radius. Verify there are no voids or delaminated concrete by sounding. Clean exposed areas by abrasive blasting with a product that is a QPL to provide an anchor profile. Provide a rough surface texture with a 1/8 to 1/4 inch amplitude in accordance with Concrete Surface Profile No. 6 to 10 per International Concrete Repair Institute (ICRI) Technical Guideline No. 310.1R.
2. Remove loose material from patch area by blasting with minimum 90 psi oil-free compressed air. Flush the area with minimum 2500 psi pressurized clean water. Remove excess water from patch area by blasting with oil-free compressed air immediately prior to application of patching material.
3. Drill galvanized or epoxy coated anchors into the repair area spaced 2-3 inches apart and use galvanized mesh or coated tie wire to create a floating mesh with spaces large enough for latex repair mixture to flow through. Provide at least 3/4-inch concrete clear cover over the anchors and tie wire. Use extreme care not to damage mild reinforcing steel or prestressing strand. Shallow repair depths may make the use of anchors impractical due to clear cover requirements.
4. Patch the area with a F-L patching mixture in accordance with Table 703-1 (Structures Patching Mixtures) of the 2020 SSC. Maintain an SSD (saturated surface dry) condition prior to placing patching mixture. Vibrate forms or use a tamping rod to consolidate the concrete patch.
5. Place a layer of wet burlap immediately over the finished concrete patch. Burlap must be soaked in water for at least 12 hours prior to placing patching mixture. Place a 4-mil thick layer of polyethylene film immediately over the burlap to protect the top surfaces from evaporation.
6. Wet cure patches using burlap and polyethylene for 48 hours and allow concrete to air cure for an additional 48 hours.

7. Air and concrete substrate temperatures must be at least 40 Fahrenheit and rising, but below 85 Fahrenheit. The forecast air temperature during the curing period must be 35 Fahrenheit or higher. Use insulating blankets if the curing period forecasted (or actual) air temperature is below 45 Fahrenheit.

Standard Structural Precast Concrete Repair Procedure #3: Major Surface Defect

This structural precast concrete repair plan is for major surface defects defined to have a minimum patch depth of 1.5 inches. This repair plan is in accordance with the following subsections of the 2020 Michigan Department of Transportation Standard Specifications for Construction (SSC):

- 712.03.F.2 - Hand Chipping Concrete Other Than Deck Concrete.
- 712.03.O - Mixing, Placing, Finishing, and Curing Concrete Patches.
- 712.03.R - Cold Weather Limitations for Placing SFMC or LMC Overlay Mixtures.
- 712.03.S - Hot Weather Limitations for Placing Overlay Mixtures.

The latex bonding agent and cement used for patching mixtures must be selected from an Approved Manufacturer found in the MSG. The aggregate must be from a MDOT prequalified source or tested for acceptance.

Procedure

Below is the standard repair procedure for major surface defect:

1. Remove unsound or loose concrete with air hammers (15-pound class or smaller) or grinding. Saw-cut areas requiring patching to an edge depth of at least ½ inch. Patch area must have vertical edges (normal to the surface) and re-entrant corners rounded with a minimum 1-inch radius. Verify there are no voids or delaminated concrete by sounding. Clean exposed areas by abrasive blasting with a product that is a QPL to provide an anchor profile. Provide a rough surface texture with a 1/8 to 1/4 inch amplitude in accordance with Concrete Surface Profile No. 6 to 10 per International Concrete Repair Institute (ICRI) Technical Guideline No. 310.1R.
2. Do not damage any prestressing strand or mild steel reinforcement. If mild steel reinforcement is exposed, remove concrete to provide 3/4 to 1 inch of clearance around the steel for anchoring.
3. Remove loose material from patch area by blasting with minimum 90 psi oil-free compressed air. Flush the area with minimum 2500 psi pressurized clean water. Remove excess water from patch area by blasting with oil-free compressed air immediately prior to application of patching material.
4. Drill galvanized or epoxy coated anchors into the repair area spaced 2-3 inches apart and use galvanized mesh or coated tie wire to create a floating mesh with spaces large enough for latex repair mixture to flow through. Provide at least 3/4-inch concrete clear cover over the anchors and tie wire. Use extreme care not to damage mild reinforcing steel or prestressing strand.
5. Repair damaged epoxy coating in accordance with subsection 706.03.E.8 of the SSC.
6. Patch the area with a C-L patching mixture in accordance with Table 703-1 (Structures Patching Mixtures) of the SSC. Maintain an SSD (saturated surface dry) aggregate condition prior to placing patching mixture. Vibrate forms or use a tamping rod to consolidate the concrete patch.
7. Place a layer of wet burlap immediately over the finished concrete patch. Burlap must be soaked in water for at least 12 hours prior to placing patching mixture. Place a 4-mil thick layer of polyethylene film immediately over the burlap to protect the top surfaces from evaporation.

8. Wet cure patches using burlap and polyethylene for 48 hours and allow concrete to air cure for an additional 48 hours.

9. Air and concrete substrate temperatures must be at least 40 degrees Fahrenheit and rising, but below 85 Fahrenheit. The forecast air temperature during the curing period must be 35 Fahrenheit or higher. Use insulating blankets if the curing period forecasted (or actual) air temperature is below 45 Fahrenheit.

Standard Structural Precast Concrete Repair Procedure #4: Hot-Dip Galvanize

The following plan is for the repair of hot-dip galvanized components and is in accordance with subsection 716.03.E of the 2020 SSC and ASTM A780.

Procedure

Below is the standard repair procedure for HDG. The fabricator must select a zinc-rich paint that meets ASTM A780 requirements and the following procedures:

1. Prepare the damaged galvanized area in accordance with paint manufacturer's instructions or as stated herein, whichever is stricter. Surface preparation must extend into the undamaged galvanized coating to ensure a smooth reconditioned coating can be affected.
2. Surfaces to be reconditioned with paints containing zinc dust shall be clean, dry, and free of oil, grease, preexisting paint, and corrosion by-products in accordance with SSPC-SP1 (Solvent Cleaning).
3. Clean the surface to bare metal, in accordance with SSPC-SP10 (Near-White Blast Cleaning) or SSPC-SP11 (Power Tool Cleaning to Bare Metal). Use a grinder and wire wheel to grind burrs, fins, tears, slivers, irregularities, or sharp edges. Sharp corners must be "broken" to promote adequate edge dry film thickness.
4. Use a clean cloth to remove any contaminant from the area being repaired. Oil free pressurized air (90 psi minimum) must be used to remove any dust or any other particles.
5. If the area to be repaired includes welds, first remove all weld flux residue and weld spatter (of a size that cannot be removed by wire brushing or blast cleaning) by mechanical means such as chipping, grinding, or power scaling.
6. Hand coat the area according to the paint manufacturer's instructions or as stated herein, whichever is stricter.
7. Allow adequate cure time before recoating or placing the repaired component into service in accordance with paint manufacturer's product data sheet.
8. Use a magnetic, electromagnetic, or eddy-current gage to measure dry film thickness in accordance with SSPC-PA2 (Measurement of Dry Paint Thickness with Magnetic Gages). QC must calibrate the gage prior to each use. The repaired area must have a coating thickness of 1.5 times the thickness or thickness equivalent specified or 5 mils, whichever is greater. Spot or area measurements, as applicable, must be taken in accordance with the SSPC– PA 2 (Required Number of Measurements for Conformance to a Thickness Specification). Record thickness measurements for the job file on QC reports and provide to MDOT's QAI.

Standard Structural Precast Concrete Repair Procedure #5: Fiber Reinforced Polymer System

The following repair plan is for elements required to be reinforced with a fiber reinforced polymer (FRP) sheet and adhesive composite system due to surface defect, honeycombing, damage, etc. and would be used in conjunction with another MDOT standard structural precast concrete repair procedure or approved unique repair procedure. This FRP repair plan is in accordance with the latest Michigan Department of Transportation Special Provision for *Fiber Reinforced Polymer Shear Strengthening System* (hereafter referred as FRP SP). A FRP system that meets the properties listed in Table 1 of the FRP SP must be provided. Submit the items listed in the FRP SP for MDOT's review and approval:

Procedure

Below is the standard repair procedure for the FRP sheet and adhesive composite system. In general, the manufacturer's recommended installation procedures must be followed. In the event of a conflict, the stricter procedures must be adhered to:

1. Verify latex repair patches have been wet cured for 48 hours and air cured for 48 hours prior to installation of FRP sheet and adhesive composite system.
2. Grind all rough edges on latex repair patches smooth after they have completely cured.
3. Remove concrete dust from surface by blasting with minimum 90 psi oil-free compressed air.
4. Verify environmental conditions (dew point, humidity, ambient and concrete substrate temperatures) are within the FRP SP requirements prior to placing primer and FRP sheet.
5. Apply the FRP primer and FRP sheet in accordance with the FRP SP.
6. FRP sheet must extend past the patch area by at least 3 inches in all directions but extend across the entire bottom flange.
7. FRP sheet must be placed with fiber orientation perpendicular (90 degrees) to the beam's longitudinal axis.
8. Allow at least 24 hours for initial resin to cure prior to performing a visual and acoustic tap test inspection of the applied FRP sheet in the presence of the Engineer.
9. Completely cure the FRP sheet and adhesive composite system per the manufacturer's recommendations before applying the protective topcoat per the manufacturer's recommendations.
10. Use the project's *Special Provision for Concrete Surface Coating,* if available, to coat the FRP system in accordance with the manufacturer's product data sheet except as modified by Section 716 of the SSC. A color sample is to be provided to the Engineer for approval. If the project does not have concrete surface coating, then a special provision will be provided. Fabricator's QCI performing coating inspection must possess one of the following endorsements:
    - National Association of Corrosion Engineers (NACE) – National Coating Inspector Training and Certification Program Session I: Coating Inspection Training.
    - SSPC-C1 Fundamentals of Protective Coatings for Industry for Industrial Structures.
    - National Highway Institute (NHI) – Bridge Coating Inspection Course.
    - Equivalent approved by the Engineer.

12DS712(P400)

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
FIBER REINFORCED POLYMER SHEAR STRENGTHENING SYSTEM

CFS:SCK 1 of 4 APPR:POJ:JAB:11-14-18

a. Description. This work consists of furnishing and installing fiber reinforced polymer (FRP) sheets to repair prestressed concrete bridge beams by applying as shown on the plans. The FRP sheet and adhesive composite system consists of layers of carbon fiber sheets with fibers oriented in the 90 degree direction as shown on the plans, attached to the concrete substrate using an adhesive, which is then top coated with a gray color protective coating. Ensure all work is in accordance with the standard specifications, and as shown on the plans, except as modified herein.

b. Materials. Materials must meet the following requirements:

The carbon fibers used in the 90 degree orientation FRP sheet must have a tensile chord modulus greater than 33,000,000 pounds per square inch (psi) and a tensile strain at failure greater than 0.8 percent when tested in accordance with ASTM D 3039 at 75.0 ±3.0 degrees Fahrenheit (F). Ensure the FRP sheet and adhesive composite system has an ultimate tensile strength greater than 2,400 pounds per inch of sheet width and a tensile strain at failure greater than 1.3 percent when tested in accordance with ASTM D 3039 at 75.0 ±3.0 degrees F. The stiffness of the FRP sheet and adhesive composite system, defined as either (1) the composite tensile modulus multiplied by the total composite area, or (2) the carbon fiber tensile modulus multiplied by the equivalent fiber area, must be greater than 198,000 pounds per inch of sheet width.

The structural adhesive used to attach the carbon composite wrap to the concrete substrate must be a highly-filled epoxy material having the minimum properties listed in Table 1:

Table 1: Structural Adhesive Minimum Properties

Properties	Minimum Values	ASTM Test Method
Tensile strength	8,000 psi	D 638
Elongation at break	4.0%	D 638
Modulus of elasticity 7 days	390,000 psi	D 638
Flexural strength	6,700 psi	D 790
Shear strength 14 days	3,500 psi	D 732
Deflection temperature	70 F	D 648
Water absorption	0.03%	

Ensure the putty used to fill voids and cavities in the concrete surface is in accordance with the FRP sheet manufacturer's recommendations. Ensure the protective top coat is concrete gray in color and in accordance with the FRP sheet manufacturer's recommendations.

Using more than one FRP sheet and adhesive composite system in a project is prohibited.

12DS712(P400)

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
FIBER REINFORCED POLYMER SHEAR STRENGTHENING SYSTEM

CFS:SCK 1 of 4 APPR:POJ:JAB:11-14-18

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Water absorption	0.03%	

Ensure the putty used to fill voids and cavities in the concrete surface is in accordance with the FRP sheet manufacturer's recommendations. Ensure the protective top coat is concrete gray in color and in accordance with the FRP sheet manufacturer's recommendations.

Using more than one FRP sheet and adhesive composite system in a project is prohibited.

Submit the following for review and approval:

1. List of all materials and manufacturers, with material safety data sheets and shipping, storage and handling requirements.

2. FRP sheet and adhesive composite system product data, submitted by the FRP system supplier, indicating physical properties, chemical properties, technical specifications, installation instructions, and maintenance instructions for the system.

3. Independent test results that verify that the property requirements stated above are met.

4. Manufacturer recommended repair procedures to be used for correcting defects that might be found during inspection or quality control (QC)/quality assurance (QA) testing.

5. Details of the FRP sheet and adhesive composite system including the method of application, epoxy impregnation, and curing.

6. Drawings that detail the geometry, placement and orientation of the carbon fibers to meet the coverage and lap length shown on the drawings.

7. Details of any construction device or access device that may be attached to the structure during construction.

8. List of QC personnel to be employed, their work history and training. The Contractor (Installer) is required to submit a QA/QC plan. Manufacturer and Contractor qualifications are to be verified in accordance with the provisions in National Cooperative Highway Research Program (NCHRP) Report 609.

c. Construction. Apply U-wrap layers of FRP to the beam webs and flanges, for a total width along the length of the member as shown on the plans. Wrap each FRP segment continuous across the beam flange and webs as shown on the plans, with fiber orientation of 90 degrees referenced to the beam longitudinal axis. Each individual layer of FRP must meet the material requirements.

QC is the responsibility of the Contractor. Because of the nature of this work, perform continuous QC monitoring. Employ one or more QC Inspector(s) in order to provide continuous monitoring of the work of this special provision. Ensure the QC Inspector(s) has(have) full stop-work authority based on quality and technical merits. Ensure the QC Inspector(s) has(have) authority to discuss the quality of the work with the Engineer and to make available all documents and records related to the work on demand, at any time, with or without the presence of other Contractor personnel. Ensure the QC Inspector(s) has(have) had adequate training in this work to be able to make decisions regarding quality and technical merits. QC Inspector(s) having specialized expertise may be employed to perform these functions for distinct phases of the work under this special provision. Submit the name(s), training and previous work history of all the QC Inspector(s), and the phase of work that they will be involved with, to the Engineer for review and approval prior to their employment. QC Inspector(s) may not be substituted without prior written approval by the Engineer.

adhesive composite system supplier on-site representative may also serve as the QC Inspector for the FRP system, provided that they perform continuous monitoring and inspection during construction of that phase of the work.

Conduct direct adhesion testing of the concrete substrate by pull-off testing in accordance with the requirements given in ASTM D 7522. Perform one pull-off test for each construction stage with the proposed FRP system. Test locations are to be approved by the Engineer and the pull-off test completed prior to installation of the proposed FRP system for each construction stage. All tests must exhibit cohesive failure within the concrete.

Remove unsound or loose concrete and prepare the surface for installation of the FRP sheet and adhesive composite system as detailed on the plans and in the proposal. Supply patching mixtures in accordance with Table 703-1 of the Standard Specifications for Construction. Form, finish, and cure the patches in accordance with subsection 712.03.0 of the Standard Specifications for Construction and as recommended by the FRP sheet and adhesive composite system supplier. The FRP sheet and adhesive composite system may be applied over patch areas no earlier than 2 hours after initial set.

Grind uneven surfaces, protrusions, and sharp edges on the concrete smooth, and round, or bevel all corners by grinding as recommended by the suppliers on-site representative, up to 1/4 inch removal limits. Remove dust from surface grinding by using an oil-free air blower or other suitable means. Clean the concrete surface as recommended by the suppliers' on-site representative. The suppliers' on-site representative must inspect and certify that the surface preparation has been performed in accordance with their recommendations. Fill voids, cavities, and bugholes with a manufacturer approved putty.

Follow the installation directions given by the FRP sheet and adhesive composite system suppliers' on-site representative and as documented in the submittals. Do not apply the FRP sheet and adhesive composite system when the ambient and concrete surface temperatures are lower than 40 degrees F, when the concrete surface is wet, when the dew point is within 5 degrees F of the concrete surface temperature, or when the relative humidity is greater than 80 percent. Provide enclosed heating such that the ambient air temperature and concrete surface temperature is brought up to and remains within the allowable limits for the material used during the entire application and curing process. The heating system must not contaminate the concrete surface or the uncured FRP system.

After allowing at least 24 hours for initial resin cure to occur, the suppliers' on-site representative must perform a visual and acoustic tap test inspection of the applied FRP sheet in the presence of the Engineer. For wet layup systems, the need for delamination repair depends on the size and number of delaminations. Small delaminations less than 2 square inches (1300 square millimeters) are permissible as long as the delaminated area is less than 5 percent of the total laminate area and there are no more than 10 such delaminations per 10 square feet (1 square meter). Delaminations exceeding these limits are to be repaired by either resin injection or ply replacement, depending on delamination size. Large delaminations, greater than 25 square inches (16,000 square millimeters), should be repaired by selectively cutting away the affected sheet and applying an overlapping sheet patch of equivalent plies with appropriate overlap length. Delaminations less than 25 square inches (16,000 square millimeters) may be repaired by either resin injection or ply replacement.

Provide a complete cure of the FRP sheet and adhesive composite system before applying the protective

and monitor the temperature of the curing surface. Maintain the temperature of the entire curing surface within the range recommended by the manufacturer and monitor the surface temperature at the beginning and ending of each shift.

Apply the protective top coat in accordance with the manufacturer's recommendations.

Corrective Work. Repair all defective areas identified by the Engineer in a manner approved by the Engineer. The FRP sheet and adhesive composite system supplier must provide field supervision for the repair work on the FRP sheets. Ensure the directions of the on-site representative are followed. Submit all repair procedures and Progress Schedule in writing to the Engineer for review and approval prior to any work. Provide the Engineer at least 2 weeks notification before the Contractor begins the corrective work and allow the Engineer full inspection of all operations and provide safe access to the areas being repaired.

Defective areas include:

1. The occurrence of visible or audible delamination of the FRP sheet from the concrete substrate.

2. FRP sheet applied over dirt, debris, or blasting debris not removed during concrete cleaning.

3. Incomplete FRP system thicknesses less than the minimums specified in the FRP system specifications.

4. Damage to the FRP system caused by the Contractor while removing scaffolding or performing other work.

d. Measurement and Payment. The completed work, as described, will be measured and paid for at the contract unit price using the following pay item:

Pay Item	Pay Unit
Shear Strengthening System	Square Foot

Shear Strengthening System includes only the area of concrete surfaces covered by the sheet and includes all costs to furnish and install all layers of the sheet, including materials and labor. The cost of shaping, smoothing, grinding, cleaning, void filling, and preparing concrete surfaces for application of the FRP sheet and adhesive composite system is included in the payment. The cost to furnish, assemble, maintain, operate, and remove the heating system to provide ambient air and concrete surface temperature within the allowable limits during the entire application and curing process is included in the payment. Individual layers of the FRP sheet and adhesive composite system will not be paid for separately.

Concrete removal, patching, forming, and placement will be paid for separately.

Standard Structural Precast Concrete Repair Procedure #6: Epoxy Repair

The following plan is for the repair of epoxy coated reinforcing steel and is in accordance with subsection 706.03.E.8 of the 2020 SSC and ASTM A775.

Procedure

Below is the standard repair procedure for epoxy coating. The fabricator must select a patching or repair material selected from the QPL and follow the following procedures:

1. Prepare the damaged areas by cleaning to remove surface contaminants in accordance with manufacturer's instructions or as stated herein, whichever is stricter.
2. Roughen the area requiring patching before applying patching material.
3. Remove rust by dry blast cleaning or power tool cleaning immediately before applying patching material.
4. Immediately treat bars in accordance with the manufacturer's recommendations and before oxidation occurs.
5. Overlap patching material onto the original coating by 2 inches, or as recommended by the manufacturer.
6. Provide at least 8 mils of dry film thickness on the patched areas.
7. Bars with 2 percent or more damaged in a 12-inch bar length is considered to be severely damaged and will be rejected.

Standard Structural Precast Concrete Repair Procedure #7: Epoxy Injection

The following plan is for the repair of concrete cracks using epoxy injection in accordance with subsection 712.03.U of the 2020 SSC. The epoxy resin used for injecting into the cracks must be selected from the QPL in the MSG.

Procedure

Below is the standard repair procedure for epoxy crack injection. The fabricator must follow the following procedures or the manufacturer's recommendations, whichever are stricter:

1. Remove leaching deposits from cracks by abrasive blasting or wire brushing.
2. Apply a temporary seal, with entry ports for adhesive, along the clean, dry crack without defacing the concrete surface. Verify the seal will contain the pumped adhesive.
3. Space ports farther apart than the estimated crack depth and close enough to allow adhesive material to travel between ports.
4. Use a wire brush to remove any surface contaminants. Clean the crack with filtered compressed air.
5. Perform injection when the concrete and ambient air temperatures are above 50 degrees Fahrenheit.
6. Begin injection at the lower entry port and continue until adhesive is visible at the port directly above, or next to the pumping port. Stop injection and seal the port. Transfer the injector from both sides of a cracked member to complete crack repair. Prevent leakage of the adhesive from the crack after injection is complete.
7. Cure adhesive at temperatures of at least 50 degrees Fahrenheit for the minimum cure time recommended by the manufacturer. Remove the seal or grind flush with the concrete surface.
8. Clean areas repaired by injection of surface contamination caused by injections.

Appendix A5: Suggested Radiographic Testing Procedure (non-mandatory)

Radiographic testing (RT) inspection of weldments as required by the contract must be performed in accordance with the applicable welding code as modified by the contract. The following procedure is a non-mandatory suggested format that meets the requirements of most MDOT contracts.

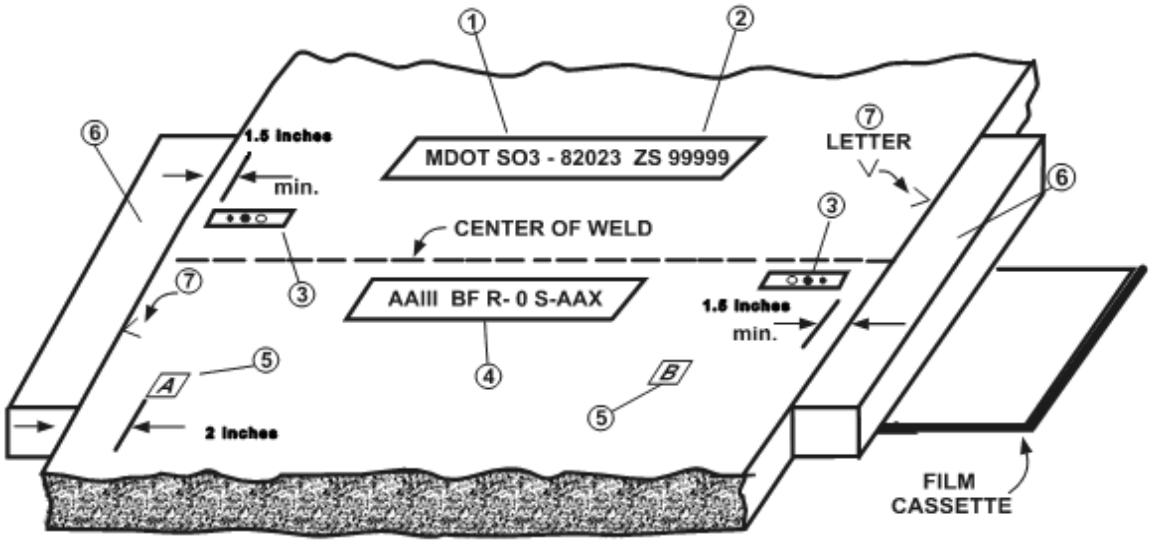
1. Fabricator must furnish a satisfactory viewer and darkroom facility for developing and viewing the radiographic film and must also provide shop space and time for all radiographic work. All safety precautions as required must be followed and enforced by the Fabricator.

2. See the contract for RT inspection requirements. All joints must be free of dirt, scale, grease, etc. prior to inspection. Flange splices must be ground flush on both sides and webs ground flush at the area to be RT (one side). The direction of grinding must be perpendicular to the length of the weld. All runoff tabs or other appendages must be completely removed before RT inspection.

3. Radiographs must be taken and interpreted by experienced and qualified technicians or radiographers as approved by the Engineer. The radiographic film and a report of the technician's interpretation must be submitted to the Engineer for their final approval before the weld is accepted. The film type must be fine grain Class I or Class II. Dimensions must be a minimum of 4.5 inches by 17 inches. Areas too large to be RT inspected on one film will require additional exposures. Limit web shot film size to 15 inches and flange shot film size to 16 inches. Either x-rays or gamma rays may be used to produce radiographs. Double lead screens must be used to back the film. Screens may be either pure lead or antimony lead with a maximum of 6 percent antimony. Tin coated lead foil or fluorescent screens must not be used. If RT inspection discloses defective welds, the defective portions must be removed and the material re-welded. Additional films must be taken of all repaired welds at the expense of the Fabricator and then submitted to the Engineer for approval.

4. The interpretation of all radiographic films must be furnished to the Engineer by the Fabricator. The interpretation report must be submitted on a form as approved by the Engineer. Should the Engineer question the interpretation of the radiographic film by the technician or should the Fabricator question the interpretation of the Engineer, a joint review will be made. The Engineer's final interpretation will govern.

5. All radiographs must be positively identified by the Fabricator in accordance with AWS D1.5. Identification lettering of radiographs must be placed on the source side along with the penetrameters. Lettering of repairs must show an "R" and the number of the repair and must be placed next to the weld identification.



Standard Radiographic Identification Layout - (numbers refer to diagram above)

Explanation

① State MDOT ID.

② Fabricator. Fabricator's initials and shop contract number.

③ Penetrameters. Use penetrameters for nominal thickness of each plate, but penetrameter for thicker plate not to exceed penetrameter for thinner plate by more than ten.

④ Weld Identification. Identification should identify the exact location of the weld in relation to piece number and location.

⑤ Location Letters. Placement of location letters is necessary to relate the location of questionable areas or defects should repair be necessary. More location letters must be added in the event more than one shot is required.

⑥ Tight fitting steel edge blocks must have a thickness equal to or greater than the thickness of the weld on all weld ends.

⑦ Lead “V” must be placed at edge to delineate the top edge on the radiograph. Additional identification may be used as required. All lead numbers and penetrameters must be placed on the source side of the plate being radiographed.

The use of "blocks" as illustrated is required. The use of these edge blocks will give a better picture of the top and bottom edges and are especially useful when the limits of the film are being crowded (e.g., one shot on a 16-inch flange).

Annexes

Shop Drawing Review Process

Find the Shop Drawing Review Process and Checklists on the MDOT website.

Welder Qualification Program

Find the Welder Qualification Program located on the MDOT website.

Elastomeric Bearing Guidance Document

Find the Elastomeric Bearing Guidance Document located on the MDOT website.

Reserved for future inclusions.