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TO: Region Engineers
Region Associate Construction Engineers
Region Construction Engineers
TSC Managers
TSC Construction Engineers

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Chief Operations Officer

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SUBJECT: **REVISED** Bureau of Highway Instructional Memorandum 2014-02
Bridge Construction and Bridge Deck Construction Inspection and Documentation
(Supersedes BOH IM 2007-02)

This document clarifies the procedures for bridge construction and bridge deck construction inspection. It also provides requirements for sampling and testing of bridge concrete, documenting bridge steel reinforcement, wet and dry bridge deck concrete depth measurements, and required documentation for bridge construction inspection. This document must be coordinated with the *Standard Specifications for Construction*, Divisions 6 and 7 of the *Construction Manual*, Special Provision 12SP604B QUALITY CONTROL AND ACCEPTANCE OF PORTLAND CEMENT CONCRETE and the *Materials Quality Assurance Procedures Manual*.

Documentation for Bridge Construction and Bridge Deck Construction Inspection

The project engineer (hereinafter referred to as Engineer) is responsible for performing all testing, inspection, and recording on the forms listed below. See Section 706 of the *Standard Specifications for Construction* and the contract documents for the Contractor's responsibilities.

- Form 1138, Bridge Reinforcing Computations
The Engineer must complete Form 1138, Bridge Reinforcing Computations, for all structural pours prior to the commencement of the pour. The Engineer must verify and record bar type, size, number, length, calculate total length, weight per foot, calculate total weight, and add remarks identifying the location of the steel (top mat, bottom mat, transverse, longitudinal, vertical, barrier, etc.).
- Form 1131, Bridge Decks Concrete Depth Measurements (required for bridge decks)
The Engineer must complete Form 1131, Bridge Decks Concrete Depth Measurements, for all bridge deck pours. See Division 706 of the *Construction Manual* for a sample form and instructions. Concrete finishing equipment is calibrated by conducting dry runs prior to the pour. Wet depth checks are taken

during the pour to verify the thicknesses as measured during the dry runs. Wet depth checks are documented on Form 1131. Note the locations of dry run measurements (ribbon or paint at longitudinal locations) and measure wet depths during the pour at or near the same locations.

- Form 1125, Permit to Place
The Engineer must complete Form 1125, Permit to Place, for all substructure and superstructure concrete pours, including bridge barrier railings. Issue permit to place only after approval of forms, bracing, and temporary works (if required), reinforcing steel layouts, and preparations for casting concrete, which may also include low temperature or cold weather protection requirements. This includes removing debris from the forms, cleaning forms, and cleaning steel reinforcement, and ensuring all expansion joint bulkheads are properly installed to the correct elevations. The Contractor must also have prepared a minimum 12-hour soak on the burlap for the bridge deck wet cure (the burlap should be hung out to drain off excess water prior to installation onto fresh concrete deck surface), have appropriate weather monitoring equipment to determine relative humidity and wind speed to verify acceptable evaporation rate prior to pours, have vibrators with rubber coated heads, and a 10-foot straight edge for checking bridge deck trueness (1/8 inch or less deviations per 10 feet). Ensure that the Contractor has the proper number of curing facilities on site and are properly outfitted to cure the QA test cylinders according to specification requirements. The curing facilities must be capable of being locked using a Department padlock to ensure that the Engineer maintains sole custody of the QA test cylinders during the initial curing period.
- Form 1174S, Inspector's Report of Concrete Placed-Structure
The Engineer must complete Form 1174S, Inspector's Report of Concrete Placed, for all structural concrete pours. See Division 6 of the *Construction Manual* for instructions. Use Contractor-supplied weather equipment to determine and record the evaporation rate for bridge deck pours. Figure 706-1 of the *Standard Specifications for Construction* must be used to determine evaporation rate. The evaporation rate must not exceed 0.20 psf/hour. Verify and record all concrete test results, cylinder identifications aggregate correction factors supplied from the concrete supplier, quantity of curing compound used, and structural concrete quantities shipped, placed, and overrun/underrun on the form.
- Inspector's Daily Report (IDR)
The Engineer must complete IDR's for all bridge work. The Engineer must record and verify permanent metal deck form information. The Engineer must record, verify reinforcement storage, and verify repair to epoxy-coated reinforcement. The Engineer must also verify the Contractor has validated acceptable evaporation rates with the appropriate weather monitoring equipment.
- MDOT Bridge Deck Construction Inspection Checklist (attached)
This checklist is an aid for documentation and inspection of bridge deck construction. The checklist identifies important items for testing and inspections, including items to observe during the bridge deck pour operations. The Engineer must complete the MDOT Bridge Deck Construction Inspection Checklist for each bridge decks constructed on the project.

Random Number

The quality index analysis for pay factor determination using Percent-Within-Limits (PWL) does not apply to structural concrete. The requirements for sampling, testing, and pay factor analysis for structural concrete are according to non-PWL application protocol. Random number sampling method is recommended for larger concrete pours where several loads of concrete will be received, but may not be practical for smaller applications. For small concrete pours, the Engineer should use judgment when selecting the precise location within the load of concrete to take the QA sample. However, keep in mind that the sample should be taken from the middle-third of the load. For larger concrete pours, the following is the required procedure to be used to ensure the random sampling process is uniform, properly documented, and reproducible. See the *Materials Quality Assurance Procedures Manual* for more information.

1. Prior to the pre-pour meeting, generate random numbers using a computer spreadsheet program or a calculator. The random numbers will be used for the cubic yardage to determine samples based on the size of the pour. Generate an excess amount of random numbers to take into account overruns or any situation where another random number is required.
2. At the pre-pour meeting, present each page that lists random numbers (cover the numbers with a separate sheet of paper) for signature of the Contractor and Engineer.
3. Place the original list in the project file; copies are provided to inspectors for field use.
4. Provide the list of random numbers to the contractor when the project is completed, if requested.
5. If the concrete is being discharged directly into the forms from the ready mix truck (or by another means other than a pump), a small adjustment in the randomly determined location from where the sample is to be taken may be necessary to ensure the sample is taken from the middle-third of the load of concrete.

Bridge Construction and Bridge Deck Construction Inspection

Permanent Metal Deck Forms

The Engineer must record and verify the source of the permanent metal deck forms. The Engineer will verify the Contractor is installing the forms as shown in the approved shop plan drawings. The approved shop drawings must be retained in the project file. The Engineer must also verify the Contractor has field drilled ¼ inch diameter weep holes in the forms at 12 inch maximum spacing along the transverse and longitudinal construction joints. See Section 707 of the *Standard Specifications of Construction* regarding field welding and welder certifications for connection of forms to bridge beams. Ensure Styrofoam used in corrugations is secure and will not be displaced by the concrete during placement. All debris such as nails, dirt, and other trash must be removed from forms prior to placing the Styrofoam and commencing with the deck pour.

Prior to installation of the permanent metal deck forms, ensure the top flange tops and sides are properly cleaned and coated.

Shear Developers

See Division 707 of the *Construction Manual* and Section 707 of *Standard Specifications for Construction* for installing and testing procedures for shear developers. Ensure the shear developers are installed in the appropriate orientation given the skew of the bridge. A list of the approved shear developers is included on the Qualified Products List in section 906.09.

Epoxy Coated Steel Reinforcement

Ensure the Contractor is storing the epoxy coated steel reinforcement per the *Standard Specifications for Construction*, and covering the reinforcement to protect it from ultraviolet rays. The Engineer must also verify the Contractor's repair of epoxy coating using a patching/repair material selected from Section 905.03.C, Bar Reinforcement (Epoxy Coating) of the Qualified Products List.

Pay special attention to those areas near drain castings or joint devices where reinforcement may have been cut. Exposed steel on bar ends must be repaired. Note the repair product on IDR. Complete Form 1138, Bridge Reinforcing Computations.

Ensure reinforcement is placed as shown on the plans and provides clear cover according to the plans and specifications. Ensure all reinforcement intersections are tied according to Section 706.03.E. Verify the Contractor is placing bar chairs as required in the *Standard Specifications for Construction* to ensure longitudinal and transverse reinforcement is placed at the correct dimensions within the bridge deck per the contract plans.

Bridge Deck Pour Sequence

The Engineer must verify the Contractor is following the pour sequence as shown on the contract plans. Any changes to the sequence must be approved and documented by MDOT Bridge Design, Bridge Field Services, or the MDOT designer, and placed in the project files. See Section 706.03.P of the *Standard Specifications for Construction* for requirements and restrictions for removal of vertical forms, including bulkheads at construction joints. The minimum cure time for the concrete prior to removal of the forms is 15 hours.

Bridge Deck Haunches

During the screed dry run, the Engineer must verify that the haunch depth and the shear developers (studs) protrude from the top of the beams a minimum 2 inches into the bottom side of the deck slab prior to the deck pour; this will ensure composite action of the beams and deck. Occasionally the haunches will become excessive in height to match existing approach conditions. In this case, the shear developers must be lengthened (up to a maximum length of 8 inches) to ensure the 2 inch minimum deck slab embedment is achieved. If the haunch grades become excessive and the 8 inch maximum will no longer provide the required embedment, contact MDOT Bridge Design, Bridge Field Services, or the MDOT designer for guidance. Additional reinforcement will be required and additional forming materials may be necessary at these locations.

For deck replacements on concrete beams, the 2 inch minimum deck embedment, described above, also applies to the steel shear developers (slab ties) cast into the top flanges. If the haunch depth on concrete beams becomes excessive, or does not provide the 2 inch embedment into the deck concrete, is not addressed in the design; contact MDOT Bridge Design, Bridge Field Services, or the MDOT designer. Additional reinforcement will be required and additional forming materials may be necessary at these locations.

Changing Night Casting of Bridge Decks

There are circumstances when the required night casting of a bridge deck may be considered for change to a day pour. Such circumstances occur primarily when the maximum daytime temperature does not exceed 60 degrees (F) and/or the nighttime temperatures are below 40 degrees (F). Consult Bridge Field Services prior to engaging in any proposal by the Contractor to change from night casting to day placement. The Engineer must document the change in the project files. The following requirements must be followed:

1. The concrete mix design generally does not incorporate a set retarding admixture, however, circumstances such as long distances from the ready-mix facility, or large pours may require their use. Consult Bridge Field Services for assistance in these situations.
2. Cold weather precautions are applied, as appropriate.
3. MDOT is credited for all cost savings from the appropriate pay items associated with the deletion for any portion of the night casting:
 - An adjustment to the cubic yard price for the item of “Superstructure Concrete, Night Casting” which was cast during the day (usually a reduction of two dollars per cubic yard. Consult Bridge Field Services for assistance).
 - Adjust the quantity for cubic yard for the item, “Bridge Ltg, Oper and Maintain,” to that which was actually night cast.
 - Delete the Lump Sum item, “Bridge Ltg, Furn and Rem (Structure No.)” (Delete only if all pours were cast during the day).
 - No adjustment for “Superstructure Concrete, Form, Finish, Cure, Night Casting” is required.

Concrete Quality Control (QC) and Quality Assurance (QA)

The Contractor is responsible for QC startup testing and all quality (process) control testing and inspection of the concrete and associated operations. MDOT is responsible for administering quality assurance (acceptance) of the concrete. The Contractor and MDOT must correlate field testing of the fresh concrete by conducting side by side temperature and air content testing of the same sampling of concrete representing the first production startup load to verify test results for temperature and air content of the concrete. For larger concrete pours, it is suggested to also conduct additional side by side correlation tests throughout the production day. This will ensure that both the Contractor and Engineer’s testing equipment and personnel are in continual correlation. These side by side correlation tests, however, must “in no way” be associated with the normal QA sampling and testing process. In other words, The Contractor cannot dispute the Engineer’s QA test results by conducting side by side QC tests during normal QA testing; correlation must be conducted independently. In the event the QC and QA air content tests do not correlate within 0.8 percent by volume of concrete, a third party tester, designated by the Engineer and not directly associated with the project should be brought in to evaluate the dispute in test results.

To verify that excessive air loss is not occurring prior to placing the concrete into the forms, the Contractor must sample and test a representative haul unit of concrete immediately after its discharge from the truck but before the pump hopper. The contractor must then sample the same load of concrete again after the pump hopper. If the difference in air content between the two samples is greater than 2.0 percent by volume of concrete, the Contractor must suspend operations and administer corrective action to determine the cause of the excessive air loss through the pump and, thus, make the necessary adjustments to their operations in efforts to reduce the excessive air loss to less than 2.0 percent prior to resuming concrete placement.

The Engineer will also conduct daily QA startup sampling and testing of temperature, slump and air content; QA sampling and testing; monitoring the Contractor’s adherence to the QC plan; and inspection of field placed materials. QA samples must be taken from the concrete as close to its final placement as practical (after the pump). A production lot may consist of an individual structural component (footing, column, cap, approach slab, barrier rail, etc...), a single day’s production, or any

combination thereof, as determined by the Engineer. The frequency of QA sampling would then be based on the total volume of concrete included in the production lot. In general, a reasonable volume of concrete representing each test (sublot size) could be approximately 50 cubic yards. Random numbers could then be used to determine the location for the test within the sublot. However, keep in mind that the QA sample must be attained within the middle-third of the truckload of concrete. For smaller concrete pours, the minimum sampling rate must be once per day.

All concrete QC and QA must be in accordance with the requirements for non-PWL applications as described in the Special Provision for QUALITY CONTROL AND ACCEPTANCE OF PORTLAND CEMENT CONCRETE (12SP604B).

Placing Bridge Deck Concrete

Verify the concrete is falling less than 6 inches from the discharge chute to the uppermost steel reinforcement for bridge deck pours and that the contractor has mobilized sufficient manpower and equipment to consolidate concrete around reinforcement. Ensure the Contractor maintains sufficient head of concrete in front of the finishing machine. When nearing bulkheads or expansion joints, the excess concrete that spills over the form must be collected and disposed of prior to the next pour in sequence.

Finishing Bridge Deck Concrete

Ensure the Contractor verifies the bridge deck trueness with a 10-foot straight edge while the concrete is still plastic. The Engineer will check the finished deck with a 10-foot straight edge and areas not within 1/8 inch in 10 feet will be corrected while the concrete is plastic, prior to placement of cure materials. Deviations exceeding a 1/8 inch in any 10-foot length will be considered defective and may require corrective action.

Texturing and Curing Bridge Decks

Ensure the Contractor textures the deck as soon as the concrete has set sufficiently to maintain the texture per Section 706.03.M.3 of the *Standard Specifications for Construction*. In colder temperatures, the concrete may not be sufficiently set up to texture and cover with wet burlap within the two hour time limit as directed in Section 706.03.M.3. For such instances, it is prudent to allow additional time for deck cure prior to texturing and placement of wet burlap. Contact Bridge Field Services in these situations. Section 104.01.A of the *Standard Specifications for Construction* gives the engineer authority in regards to quality and acceptability of the work performed and manner of performance in this scenario. The Engineer must also ensure the Contractor applies a curing compound at a rate not less than one gallon per 150 square feet of surface, immediately after the sheen of bleed water has left the textured concrete surface. Ensure the Contractor wet cures the bridge deck per Section 706.03.N.1.B of the *Standard Specifications for Construction*.

The Engineer must ensure the Contractor has soaked the burlap a minimum of 12 hours prior to beginning the deck pour, that the burlap is placed (excess water removed from the burlap prior to installation) as soon as the curing compound has dried sufficiently to prevent adhesion, and that the concrete will support it without deformation, but not more than two hours after the deck was cast under normal temperature conditions. Do not use products such as Burlene, which combine the burlap and vapor barrier, solely for the wet curing. These products used alone result in the soaker hoses being in direct contact with the fresh concrete. The hoses must rest on the burlap which is then covered by the appropriate vapor barrier. The Engineer must ensure the Contractor provides a network of soaker hoses and a system that capable of applying cure water uniformly and continuously for at least the entire seven day wet cure period, and that the entire deck surface is

covered with a minimum 4 mil polyethylene film. The continuous wet cure must be maintained at all times throughout the entire 7-day wet curing period.

Concrete Delivery Tickets

The Engineer must collect, verify the mixture proportions (JMF) and record discharge time, and sign each concrete delivery ticket prior to discharge.

Cold Weather Protection

Ensure the Contractor follows cold weather precautions in accordance with Section 706.03.J of the *Standard Specifications for Construction* and note if a pay item is included for this in the plans. There may also be a monitoring requirement via special provision to assess the effectiveness of low temperature protection measures. If the National Weather Service forecasts temperatures below 40 degrees (F) during the curing period, preparations for low temperature protection, such as insulated blankets, must be made. If the National Weather Service forecasts temperatures below 20degrees (F) during the curing period, the Contractor must provide materials and equipment forms and concrete..

Ensure the Contractor does not place superstructure concrete when temperatures are below 40 degrees (F), unless forms, metal surfaces, and adjacent concrete surfaces are preheated to above 40 degrees (F). However, do not allow placement if the air temperature is below 35 degrees (F).

If temperatures are projected to fall below 40 degrees (F) for eight or more hours after initial placement, ensure the Contractor protects the top of the freshly cast concrete as soon as possible.

Ensure the Contractor maintains a minimum concrete temperature of at least 40 degrees (F) during the curing period.

If temperatures fall below 15 degrees (F) during any time in the curing period, ensure the Contractor circulates heated air in accordance with subsection 706.03.J.2.b of the *Standard Specifications for Construction*.

Notification

Notify Corey Rogers at 517-930-2768 or Scott Hobner at 517-202-4046 of Bridge Field Services one week prior to the commencement of the bridge deck pours.

Chief Operations Officer

Bureau Director of Field Services

FHWA Approval: 03/11/14

Attachment

BOFS:OFS:MG:MC:CR:drc

Index: Structures

cc:	CFS Division Staff	P. Collins	D. Wedley	ACM	MITA
	M. Chaput	B. Wieferrich	P. Wiese	ACEC	MML
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MDOT BRIDGE DECK CONSTRUCTION INSPECTION CHECKLIST 0395

Control Section:	Project No.:	Date:
Structure No.:	Structure Location:	
Contractor:	Concrete Supplier:	
Inspector:	Engineer:	
A. Pre-Pour Meeting		Initials
Contractor submitted Concrete QC plan for subsection 701.03.F.1		
Concrete Supplier and Contractor Concrete Testing Personnel identified		
Generate random numbers for concrete quality assurance sampling		
Approved Concrete Mix Design(s) submitted, including Aggregate Correction Factor		
Contractor to submit deck lighting scheme for approval 706.03.I.2		
Contractor to submit for approval of equipment to be used to determine relative humidity and wind velocity at site per subsection 706.03.H.2		
B. Prior to Pour		
Inspect forms and check for grade, straightness, tightness, and location 706.03.D		
Review approved stay-in-place forms and shop drawings prior to installation		
If using metal stay-in-place forms ensure that Styrofoam is in the corrugations and secured (if required). Ensure ¼ inch weep holes are drilled 12 inches on center along transverse and longitudinal construction joints 706.03.D.4		
Ensure the epoxy coated steel reinforcement is properly stored and covered prior to placement to prevent damage from sunlight 706.03.E.1		
Inspect steel reinforcement, including bar chair location and spacing 706.03.E.4		
Verify bar size, quantity, location, spacing, clear cover, laps, and ties of transverse, longitudinal and vertical steel reinforcement. All bars must be tied in accordance with subsection 7.06.03.E. Record quantities on Form 1138, Bridge Reinforcing Computations		
Repair epoxy coated re-steel per subsection 706.03.E.8. Verify product on the Qualified Product List per subsection 905.03. Record product on IDR		
Ensure the bridge deck is free from debris per subsection 706.03.H.1		
Verify that quality assurance testing personnel are on site to perform verification testing		
Ensure the bulkhead for construction joints are in-place, secure, and at the correct grade. Check contractor's grades and verify during the dry run		
Ensure vibrators have rubber coated heads per subsection 706.03.H.1		
Perform dry run per subsection 706.03.M.1 and record wet depth measurements on Form 1131, Bridge Decks Contract Depth Measurement. Note locations. Saw cut bulkheads after dry run approval		
Ensure contractor furnishes a 10-foot straight edge per subsection 706.03.M.1		

Ensure the burlap has been soaking a minimum of 12 hours before the pour, per subsection 706.03.N.1.b. and excess water has been removed	
Ensure the equipment to determine relative humidity, temperature, and wind velocity is on site and working properly. Record evaporation rate on Form 1174S, Inspector's Report of Concrete Placed (Figure 706-1)	
Ensure the equipment for applying curing compound is in working condition	
Issue Form 1125, Permit to Place	
C. During the Pour	
Record Aggregate Correction Factor on Form 1174S, Inspector's Report of Concrete Placed	
Ensure contractor is performing QC testing, including yield tests	
Complete Form 1174S, Inspector's Report of Concrete Placed	
Verify concrete delivery tickets match the concrete mix design	
Perform concrete QA testing	
Ensure engineer tags the quality assurance cylinders	
Test concrete at the pump discharge and the concrete truck, according to 12SP604(B) QUALITY CONTROL AND ACCEPTANCE OF PORTLAND CEMENT CONCRETE	
Record elapsed time interval on every delivery ticket between charging the mixer and the placement of the concrete. Sign the concrete delivery tickets	
Vibrator with rubber coated heads being used within 15 minutes of placement	
Ensure contractor does not over vibrate or over finish the concrete	
Ensure concrete does not freefall more than 6 inches to the top mat deck reinforcement	
Ensure a sufficient head of concrete is maintained in front of the finishing machine to provide mix consistency during placement.	
Perform wet depth checks near locations of the dry run checks and record measurements on Form 1131, Bridge Decks Concrete Depth Measurement	
Ensure contractor checks deck tolerance with a 10 foot straight edge both longitudinally and transversely. Address deficiencies greater than 1/8 inch in any 10 feet.	
Do not allow the contractor to apply water to the deck surface to aid in finishing. If necessary, allow only with an approved fog sprayer and only when approved by the engineer	
Inspect texturing per subsection 706.03.M.	
Verify the white curing compound was applied at the appropriate time and at the correct application rate	
Verify the wet cure (burlap, soaker hoses, and polyethylene) was applied at the appropriate time	
Verify the low temperature protection was applied as necessary per 706.03.J2.b.	
D. After the Deck Pour	
Ensure that the contractor waits a minimum of 15 hours to strip bulkheads after completion of the pour	
Do not allow casting of succeeding structure portions, that are placed on top of the bridge deck, until the deck concrete has wet cured for 7 days. Saw cut construction joints within 24 hours after the deck pour. Inspect deck tolerance 1/8 inch in 10-foot with 10-foot straight edge prior to acceptance.	