CHAPTER 500 – STRUCTURES

SECTION 501 – EXCAVATION AND BACKFILL FOR STRUCTURES

501.01 GENERAL

This work consists of excavating material for the construction of major structures and backfilling, stockpiling, or disposing of excess excavated material.

501.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Contractor’s sources of granular backfill material, underdrain, filter fabric, etc.
- Contractor’s source of materials and CLSM (flowable fill) mix designs, and the need for the concrete plant to have a current certification.
- Any “phased” construction that may be required, including temporary earth retaining structures (sheet piling).
- Contractor’s plan for diversion of the existing stream during construction, if necessary.
- Applicable environmental regulations, including the US Army Corps of Engineers (USACE) 404 Permit, and Section 220 of the Standard Specifications.
- Need for the Resident Engineer to approve stream bed disturbance, work road locations, and disposal of excess excavation.
- Contractor’s responsibility to notify the Resident Engineer when excavation is ready for inspection and prior to placing any structures.

B. Acceptance of Materials

As soon as practical, obtain sufficient samples of materials to be used for the backfill of the structures. Perform applicable tests on these materials to determine:

- Soil classification for select backfill: AASHTO M 145.
- Maximum density and optimum moisture (proctor) for unclassified, select and granular backfill: AASHTO T 99 or T 180.
- Gradation for granular backfill: AASHTO T 27. [Document in Template T 27].
- The source of materials and CLSM (flowable fill) mix designs, and verify that the concrete plant has a current certification. Trial batches will be required if the CLSM is not being provided by a previously used source.

When reporting the maximum density, provide a physical description of the material/soil to assist the Inspector in determining the proctor to be used when measuring compaction.

C. Preparatory Work and Contractor Work Plans

To ensure the integrity of a structure, considerable attention must be paid to structure excavation and backfill. Various types of structure excavation and backfill and various methods of measurement and payment exist. Often, the payment limits will not match the physical limits used in the construction of a facility. Before the work begins, it is essential to study the Contract Plans, Standard Plans, Standard Specifications, Special Provisions, and the work site. Also, take the following steps:

1. Before the Contractor begins excavation operations, review the Plans and stakes to determine the following:

    - Whether the structure will clear other facilities;

    - Whether the structure will function as planned in this location or should be adjusted; and

    - Whether sufficient data is available for quantity calculations, including original cross sections when necessary.

2. When the Contractor is installing culverts in an embankment, ensure the embankment is at the elevation specified.

3. Before allowing the Contractor to begin backfilling, inspect the structures for defects, and ensure that any required strutting or bracing, as shown on the Plans, is in place.

4. Test backfill material for compliance with specifications and test compaction.

5. Approve the Contractor's plan for stream bed disturbance, work road locations, and disposal of excess excavation prior to allowing the start of such work.

6. Review the method of payment / measurement (plan quantity or measured in place).

7. Ensure original cross sections have been taken.

D. Safety and Environmental Issues

In some types of soil it is necessary to provide shoring or to slope the ground beyond the neat lines shown in the Project Plans or Standard Drawings in order to avoid caving. The Contractor's slope, shoring and trenching plan must conform to the Occupational Safety and Health Administration (OSHA) standards. Therefore, all excavations will automatically be referred to the OSHA Standards for excavation. This requirement is necessary for the safety of the inspection personnel as well as the Contractor's personnel.

501.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

Perform compaction tests (except for CLSM backfill) to ensure compliance with the Contract. Also, determine the frequency of such testing, ensuring sufficient frequency to determine compliance with requirements. Determine frequency based on variables such as the nature of the material and the efficiency of the Contractor's methods. At the beginning of backfilling, take sufficient tests to establish the amount of effort required to attain the required compaction.

The minimum frequency of density testing must be in accordance with the FAST Guide. At the start of operations on a Project, it is advisable to perform more frequent tests to evaluate the effectiveness of compaction methods, material, and moisture content, as well as the variability of the entire backfill and compaction process. The tests must be timely so that there is a minimum of delay to the Contractor's operations.

Perform applicable tests on these materials to determine:

- Compaction of embankment for unclassified, select and granular backfill: AASHTO T 310. [Document in Template C95001]
- Soil classification for select backfill: AASHTO M 145
- Gradation for granular backfill AASHTO T 27. [Document in Template T 27]

Test CLSM in accordance with the following methods:

- Flow test: ASTM D 6103. Spread diameter must be 8 inches or greater.
- Compressive strength tests: ASTM D 4832. [Document in Template C94004] Compressive strength at 28 days must be between 100 psi and 800 psi.

If visible changes occur in the material perform the following tests:

- Soil classification: AASHTO M 145.
- Maximum density and optimum moisture (proctor): AASHTO T 99 or T 180.
- Compaction of embankment: AASHTO T 310. [Document in Template C95001]

B. Equipment and Methods

Before embankment operations begin, the Contractor must bring certain equipment onsite. This includes adequate water trucks, hauling equipment, disc, and compaction equipment suitable for the type of soils being used (e.g., steel-wheel for granular material and sheep foot for clayey material).

Verify that the Contractor provides a water source and watering equipment of sufficient capacity to ensure proper moisture content and compaction of the material being worked.

The Contractor must have equipment onsite to properly manipulate and compact the material to achieve uniformity in the material and moisture content. The Contractor could use a motor grader, tractor with disc and sheep foot, etc. to accomplish this.

1. Fine-Grained Materials

Generally speaking, earth embankments with enough plasticity index to allow the material to ball up in your fist are best compacted by use of a sheep foot roller in combination with a pneumatic roller. When rolling first begins with the sheep foot roller, you will notice a line in the surface of the fill section created by the outside edge of the roller drum as it cuts into the embankment material. As proper compaction is achieved by the sheep foot roller, the line marks will no longer be created by the outside edge of the roller drum because the sheep foot roller will have "walked itself out" of the embankment material, and the roller will be walking on the nubs of the sheep foot such that the outside edges of the roller drum no longer touch or cut a line into the lift being compacted.

2. Granular Materials

Generally speaking, sandy materials are best compacted by flooding, vibration, or a combination of the two. A vibrating flat steel drum roller combined with water achieve the best results.

COMPACTOR TYPES

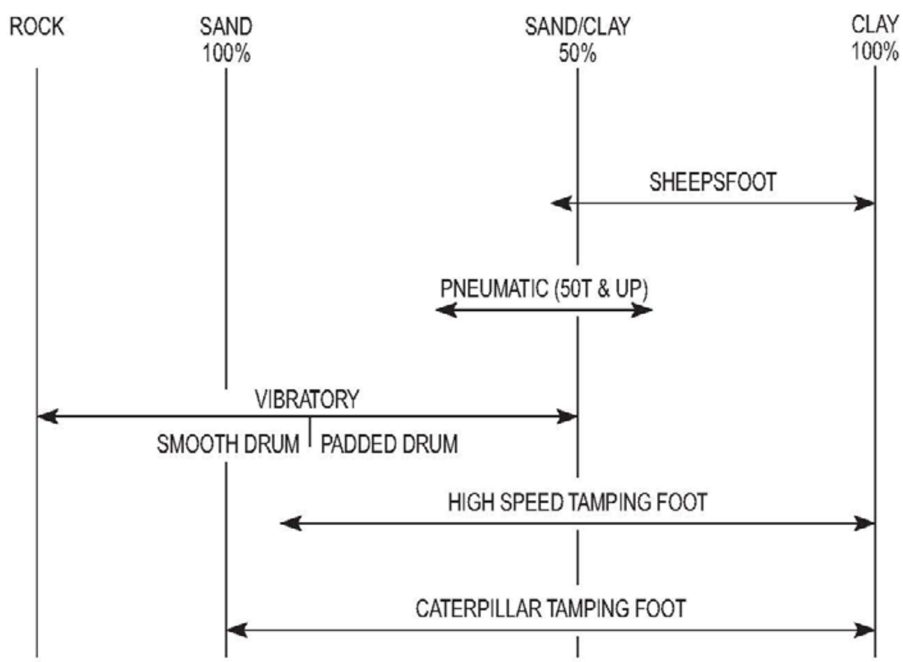
Compaction equipment can be grouped generally into the following classifications:

sheepsfoot
vibratory
pneumatic
high speed tamping foot
chopper wheels (see Landfill Compactor section)

Combinations of these types are also available, such as a vibrating smooth steel drum.

For ease of comparison, the compactors have been placed on the Zones of Application Chart shown below. This chart contains a range of material moistures from 100% clay to 100% sand, plus a rock zone. Each type has been positioned in what is considered to be its most effective and economical zone of application. However, it is not uncommon to find them working out of their zones. Exact positioning of the zones can vary with differing material conditions.

RANGES OF SOIL TYPES FOR SOIL COMPACTION EQUIPMENT



C. Construction Operations

1. Excavation

(a) General

Observe the excavation and bring to the Contractor's attention all trenching, sloping or shoring that appears to violate OSHA standards or is creating an unsafe condition for workers.

Periodically inspect the excavation. Remind the Contractor of the provisions of Section 501.04.A(2)(e) of the Standard Specifications, which requires the Contractor to notify the Resident Engineer when structure excavation is completed substantially to grade.

Before fine grading begins, ensure the excavation is completed to the plan dimensions and elevations, and is of suitable material.

Observe fine grading to ensure compliance with requirements for grade and culvert beddings.

Obstructions encountered will be handled in accordance with Section 501.01.C of the Standard Specifications.

For foundations under water, the Contractor must shore and dewater the excavation until the concrete is placed.

The Contractor must not place forms, rebar, or concrete until the foundation is approved by the Inspector or Resident Engineer.

(b) Rock and Unsuitable Material

Geotechnical borings are not usually taken at boxes. Boxes are designed assuming a similar material for the entire length of the box. Therefore, if rock outcrops are encountered during excavation, contact the Bridge Division for recommendations on any changes necessary. Usually, the solution will be to over excavate the rock 2 feet below the bottom of the box and replace it with aggregate or select borrow. If soft, organic, or other unsuitable foundation material (i.e. muck) is encountered, it must be removed and replaced with aggregate, select borrow, concrete or CLSM. Before allowing the Contractor to proceed with over excavation, approve the depth to which the rock or unsuitable material must be removed.

The volume of unsuitable material ultimately removed to obtain a consistent foundation will have to be measured for payment. To compensate the Contractor for the removal and replacement of the unsuitable material, double the volume of the unsuitable material removed below the bottom of the box footing, and pay for it as Structural

Excavation, Unclassified at the Contract unit price. If the Contractor over excavates below the foundation without prior approval, direct the Contractor to replace the material with aggregate or select borrow at no cost to the Department.

For structural elements that have foundations on rock (retaining walls, spread footings, etc.) monitor the excavation and compare it to the geotechnical data provided in the Plans. If the excavated material is not similar to the geotechnical data, notify the Bridge Division to determine if the foundation needs to be changed. Of particular concern is if the elevation of rock is not where it was assumed in the Plans or it is a different kind of rock. Once the excavation has reached the bottom of foundation elevation, check the rock surface soundness and consistency. Any seams must be cleaned and filled with concrete or CLSM before the footing is placed. The Contractor must remove any loose, unsound, or yielding areas and replace it with concrete or CLSM. Some rocks, such as shale, deteriorate quickly when exposed. Therefore, it is critical that the Contractor pursue completing and backfilling the foundation once it is open. Check the foundation daily for deterioration of the rock, loose material, or buildup of dirt.

(c) Quantity Adjustments

Enter in the daily report any orders to increase excavation (undercut), and enter sufficient data in the appropriate records to support additional payment.

Pay for additional quantity by measuring such quantity and including it in the appropriate contract records when no extra work is involved.

2. Backfill

Do not allow the Contractor to place backfill material against a concrete structure until the concrete has developed the minimum strength specified for that structure. Section 509.04.I(2) of the Standard Specifications requires that a minimum compressive strength of 80% of the design compressive strength be obtained. In no case shall backfill be placed before 72 hours after casting. Use field cured cylinders for determining compressive strength.

Ensure that the proper type of backfill material is used as required by the Plans: CLSM, Granular, Select or Unclassified. Section 501.02 of the Standard Specifications allows the Contractor some latitude in selecting the material while still requiring a material that is free of objectionable material, and that conforms to gradation, plasticity index, and resistivity requirements (for MSE walls). Objectionable materials include frozen lumps, chunks of clay, vegetation, foreign material, form lumber, rocks larger than 3 inches, and degradable or hazardous matter.

Ensure that the Contractor places pervious backfill material around underdrain pipe as specified, and ensure that the underdrain pipe is not being crushed during compaction.

Inspect the earthen backfill to ensure it is brought up and compacted uniformly around the structure and in layers no greater than 6 inches thick. It is advisable to mark the wall or area being compacted in 6-inch increments as each lift is placed in order to ensure proper lift thickness. Backfill placement on one side must never be more than 2 feet above backfill placed on any other side. Rocks larger than 3 inches may not be placed against concrete surfaces. Care must be taken to extend the compacted area as far as necessary in order to notch into firm material. Benching requires cutting into compacted material both laterally and longitudinally, with all material to be compacted. This may be an effective method to achieve the compaction requirements.

Ensure that all conditions described in the specifications are met before permitting “ponding” and “jetting.” “Ponding” means flooding the backfill material for a period of time (by erecting dams or dikes) so that water will pond on the material. “Jetting” means forcing water into the layer of backfill material through a small diameter pipe. Ponding alone is not permissible because it does not give uniform or adequate consolidation. Pressure jets must be inserted at the bottom of the backfill material at close, uniform intervals. The use of ponding and jetting will not be allowed while backfilling behind abutments or wingwalls. Prohibit the use of any compacting equipment or methods that may displace or damage structures or otherwise adversely affect foundations or adjacent embankments.

When specified in the Plans, or approved by the Bridge Division as an alternative, the Contractor may use a CLSM backfill material that conforms to the requirements of Section 701.19 of the Standard Specifications. One of the advantages of CLSM backfill is that it provides adequate support on the underside of pipes where compaction of ordinary backfill material is difficult. When CLSM backfill is used, ensure that it is adequately fluid and is placed so that it completely fills the area around the structure. The Contractor must avoid “floating” the culvert. Do not allow CLSM backfill to be placed in lifts greater than 4 feet in thickness, to allow for adequate curing (bleeding) of the material and to prevent overturning any vertical elements due to excessive fluid pressures. It is advisable to mark the wall or area being backfilled in 4-foot increments as each lift is placed in order to ensure proper lift thickness.

D. Safety and Environmental Considerations

Do not allow placement of excess material in the stream bed or structures.

Ensure worksite is protected in accordance with the USACE 404 Permit requirements and Stormwater Pollution Prevention Plan (SWPPP).

Discuss OSHA requirements as needed with the Contractor.

If suspected hazardous materials are encountered, contact the Resident Engineer for Environmental Programs Division action.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Quantity and classification of material excavated: planned and / or undercut.
- Quantity and classification of material backfilled: unclassified, select, granular or CLSM.
- Location or Structure Number where work is being performed.
- When the foundation is approved for the placement of forms, rebar, or concrete.
- Any conditions requiring corrective actions, the individual contacted, and their recommendations.

2. Measurement and Payment

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

The final quantities for these pay items will be determined by one of the methods defined in section 501.05 of the standard specifications.

Documentation of these items will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template. Note: The same template will be used for each method of measurement, but the information required will depend on the option selected.

a. Select the appropriate pay item from the list of contract pay items.

b. Open the ‘DWR Templates’ icon in the toolbar.

c. Select the payment option from the radio button list (3D Measured or Calculated Quantity) that is going to be used as the method of measurement for the work performed.

d. Depending on the option selected, enter the following information:

    1. Three Dimensional Measured Quantity Option.

This option can be used for progressive payments or for documenting the final quantity of volumes necessary for undercut, excavation of structures and isolated locations.

a. In the appropriate fields, enter both a descriptive location and the station to station extents.

b. Input the measured length, width and depth to calculate a volume.

c. For additional areas or additional locations, with different dimensions, select the 'New Row' button.

2. Calculated Quantity Option.

This option will allow the input of quantities calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), and can be used for progressive payments or for documenting the final quantity of areas. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

a. In the appropriate fields, enter both a descriptive location and the station to station extents.

b. In the Calculated Quantity field, enter the calculated quantity (CY) of the item completed, ensuring that the total quantities to date does not exceed plan quantity.

c. In the 'Remarks' area provide sufficient information to provide any additional comments specific to the work performed.

d. In the Book/Folder/Envelope # field provide the location of the documentation for the calculations.

e. For additional areas or additional locations, with different dimensions, select the 'New Row' button.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

501.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

Ensure that the "final" density, moisture and compressive strength requirements have been satisfied.

Perform applicable tests on these materials to determine:

- Compaction of embankment for unclassified, select and granular backfill: AASHTO T 310. [Document in Template C95001].

- Compressive strength tests for CLSM backfill: ASTM D 4832. [Document in Template C94004]. Compressive strength at 28 days must be between 100 psi and 800 psi.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

When calculations utilize the Average End Area Method or the Surface to Surface Method, include a letter with the documentation which provides the following:

- Method and equipment used for measurement of the areas (GPS, Data Collection, etc.)

- Software used for calculations (SurveyPak, Inroads, GeoPak, etc.)

- Detailed explanation of the calculation method (average end area, surface to surface, etc.) utilized to develop the quantities

- Any additional documentation as required by section 202.05 of the standard specifications

- The "Final" earthwork quantity summary for each pay item

- Signed by the individual responsible for producing the documentation for these quantities

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

Ensure that the placement and compaction of the backfill material has not damaged the structure or underdrain pipe, temporary erosion control measures, or other permanent work.

Check the drainage structure and stream bed to ensure there is no soil or debris accumulation.

Restore bank cuts and work roads to their original shape, density and condition.

CHECKLIST – EXCAVATION AND BACKFILL FOR STRUCTURES

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Has the Resident Engineer approved:					
Streambed disturbance?					
Work road location?					
Disposal of surplus?					
Excavation or dredging in natural streambeds?					
Contractor's plan for protection of workers in excavations?					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Excavation:					
Excavations are staked according to plan.					
Material excavated is similar to boring descriptions.					
Elevation of rock is similar to the plan elevation.					
Foundation is approved before forming.					
Quantities of unsuitable material below the foundation are approved for removal and replaced with suitable material.					
Contractor follows safety plan for employees and inspectors.					
Obstructions are identified and Contractor notifies the Resident Engineer in writing within 24 hours.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Backfill:					
Concrete has reached required compressive strength before backfilling.					
Under-drains and drainage material are in-place, clean, and functioning.					
CLSM is limited to lifts of 4 feet or the limits in the plan notes.					
Backfill lifts are limited to 6 inches.					
Lifts are brought up uniformly around the structure.					
Lifts are compacted to 95% standard density.					
Maximum rock size in backfill is limited to 3 inches and no frozen lumps.					
Jetting is not used.					
Rollers, vibrators, etc are operated parallel to the face of the structure.					
Care is taken to ensure that compaction does not damage under-drains.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Erosion and sediment control measures and drainage structures are free of soil and debris accumulation and are functioning properly.					
Disturbed areas have been restored to their original condition and density, as necessary.					

SECTION 502 – FORMS, FALSEWORK AND TEMPORARY WORKS

502.01 GENERAL

This work consists of designing, constructing, and removing temporary structures used for highway bridge structures.

502.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Use of falsework to support loads, including formwork, until the structure becomes self-supporting.
- Contractor's responsibility for falsework design and construction.
- Contractor's responsibility to submit working drawings in accordance with Section 105.02 if falsework is taller than 14 feet or over traffic.
- Contractor's responsibility to submit design for stay-in-place forms and deck panels for approval by Bridge Division.
- Contractor's responsibility to submit cantilever bracing detail for steel bridge beams for approval by Bridge Division.
- Contractor's responsibility to obtain inspector's approval of formwork prior to placing concrete [502.02B(1)].

B. Acceptance of Materials

Advise the Contractor that materials to be used for construction must comply with the requirements of Section 502.02 of the Standard Specifications.

C. Preparatory Work and Contractor Work Plans

The Contractor's Professional Engineer shall determine the need for falsework drawings, if the falsework structure is taller than 14 feet or is over any type of traffic. Working drawings will need to be prepared by a registered professional engineer as per Section 502.04.A(1) of the Standard Specifications.

D. Safety and Environmental Issues

Discuss with the Contractor its plan to protect workers and traffic during construction. The plan must address:

- Fall protection for workers
- Measures to prevent tools, material etc. from falling on traffic beneath
- In the event that the erection of falsework reduces vertical clearance for traffic, modification of the "clearance" sign, and notification of the Department of Public Safety and Bridge Division

- Traffic control during construction

502.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

Advise the Contractor that materials to be used for construction must comply with the requirements of Section 502.02 of the Standard Specifications.

B. Equipment and Methods

Ensure that the Contractor uses equipment sufficient to adequately construct falsework.

C. Construction Operations

1. Form Lumber

To produce a clean, uniform finish on exposed concrete surfaces, acceptable form lumber must be used as per Section 502.02.B and 502.04.B(2) of the Standard Specifications. Compliance will help ensure the desired surface appearance of the finished structure. In addition, check that exterior corners are formed with a chamfer strip or other suitable means to produce smooth, even edges. See Figures 502:1, 2 and 3 below.

2. Bracing Considerations

The Contractor is responsible for providing adequate bracing of all formwork. Inadequate bracing can sometimes cause bulges in abutments, wing walls, and retaining walls. Bracing must be constructed such that the finished product will be in compliance with the requirements specified in Section 502.04.B(1) of the Standard Specifications.

3. Foundation Systems

Adequate foundation systems must be provided to support the weight of falsework and construction loads. This is particularly important during the construction of concrete box girders and pier caps where segmental pouring sequences are employed. Partially completed structural elements cannot be expected to carry the weight of concrete used in subsequent pours, and adverse cracking will generally occur if falsework settles.

Verify that the foundation is constructed in compliance with the falsework drawings and is in compliance with Section 502.04.A(3) of the Standard Specifications.

4. Inspection Considerations

Before the concrete pour, thoroughly inspect formwork for trueness to line and grade, warping, smoothness of form faces, condition of form ties, proper bracing, tightness of joints, and cleanliness of forms (e.g., shavings, sawdust). Consider the following additional guidelines:

(a) Falsework Drawings and Certification

For falsework meeting the requirements of Section 502.04.A of the Standard Specifications, ensure that the falsework drawings have been approved by Bridge Division and that the Contractor has submitted a proper letter of falsework certification. See Section 502.04.A(8) of the Standard Specifications for additional information.

Prior to placement of any concrete supported by falsework, the Contractor's Professional Engineer, on the engineering company's letterhead, shall prepare and submit a letter of falsework certification to the Contractor. The Contractor shall submit the certification letter to the Resident Engineer. The certification letter must contain the following information:

- project number,
- job piece number,
- project location,
- date,
- Contractor's name,
- name of Contractor's Professional Engineer,
- Professional Engineer's Oklahoma PE license number,
- structure identification,
- description of portion of structure supported by falsework, and
- statement of certification.

The certification letter must be signed and dated by the Contractor's Professional Engineer. The statement of certification in the body of the letter must be as follows:

> *I hereby certify that falsework materials and construction have been inspected and that all*

> *falsework design, materials, and construction conform to the requirements of the Contract and are safe for the placement of concrete.*

Note that a separate certification letter is required prior to each concrete pour that is supported by falsework.

(b) All Forms General

Section 502.04.B(1) of the Standard Specifications requires the inspection and approval of forms by the Resident Engineer before concrete can be placed.

Ensure that all forms are in good condition, clean, and on line and grade, considering adjustments for settlement and dead load deflection.

Ensure that methods to measure falsework movement are in place before concrete is placed. Tell-tales must be attached to the soffits of decks. In order to determine if the overhang is deflecting differently than the center of the deck, tell-tales must be placed along the centerline of the deck and under the outer edge of each overhang at least at 1/4 points along the span. Monitor the tell-tales during the deck placement to ensure that there is consistent settlement under the overhangs and in the center of the bridge. If the overhangs settle more than the center of the bridge, the center of the deck will be thin. Therefore, if it is not consistent, stop the deck placement, determine the cause of the differential movement, and make adjustments for it before continuing.

In order to prevent differential settlement of deck overhangs to the center of bridges, ensure that the exterior beams are braced to prevent rotation in accordance with Section 502.04.A(6) of the Standard Specifications.

Ensure the clearances to piles meet the requirements of Section 514.04.C(3) of the Standard Specifications. It requires that forms provide 6 inches of clearance to the pile face for foundations on the ground (such as abutments) and 4 inches to the pile face on pier caps

(c) Removable Forms

Section 502.04.B(1) of the Standard Specifications provides tolerances for formed concrete. The forms must meet these tolerances with any adjustment for anticipated settlement.

Removable forms must be coated with a releasing agent that does not discolor the concrete. The form panels must be at least 3 foot by 6 foot, in good condition, with no surface defects. The forms must be mortar tight without the use of visqueen and not deflect during concrete placement. Figure 502:1 provides an example of acceptable form work.

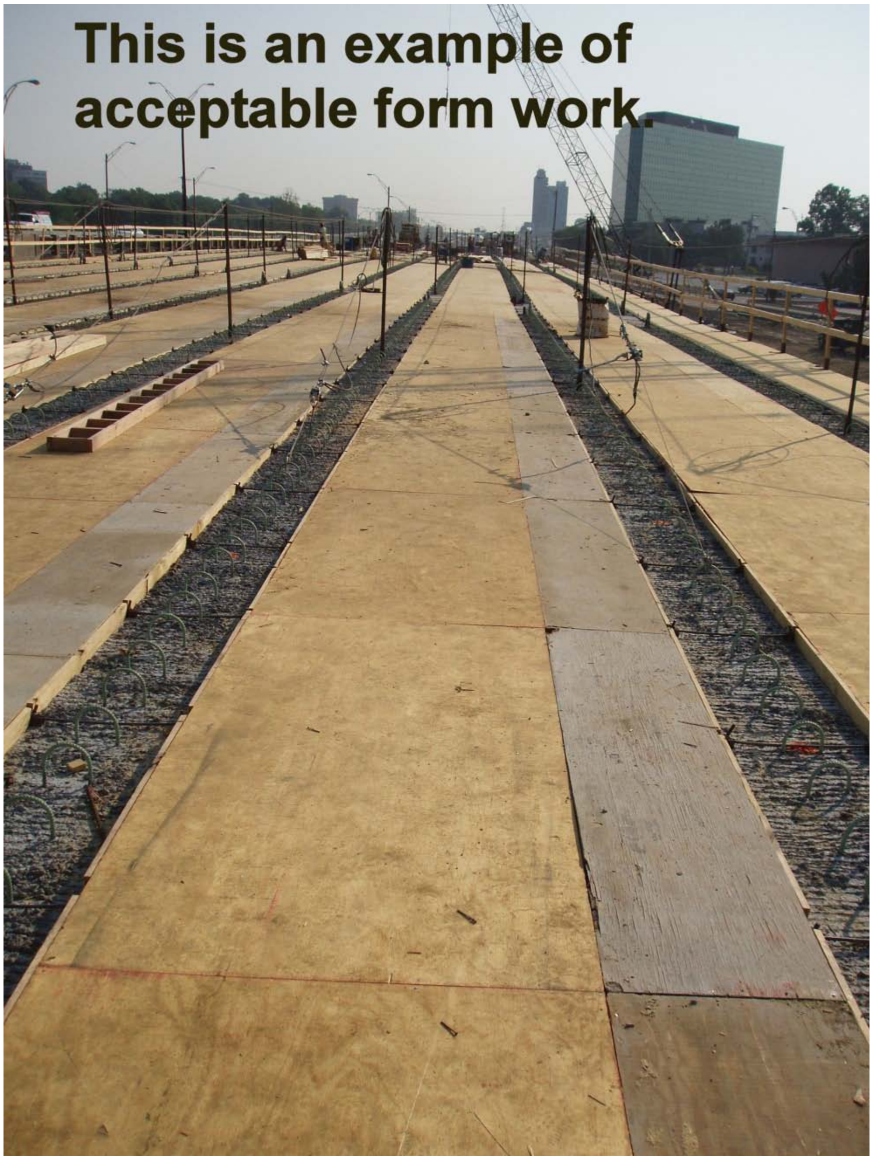


Figure 502:1. Photo. Acceptable Form Work

In contrast to the above figure, Figure 502:2 provides an example of unacceptable form work. Note the poor condition and small sizes of wood used.

Figure 502:2. Photo. Unacceptable Form Work

To the extent possible, identify and notify the Contractor of any unacceptable forms prior to their installation (see Figure 502:3).

Figure 502:3. Photo. Unacceptable Forms

It is common practice in Oklahoma for Contractors to try to overcome unacceptable plywood forms by using visqueen to seal the forms. The specifications do not allow the use of forms that have any defects. Therefore, visqueen would not be necessary.

However, if visqueen is used, note that it is not a substitute for mortar tight forms in good condition. Also, ensure that the visqueen does not lap over the beams. It can act as a bond breaker, and the beams are designed to be composite. (See Figure 502:4 of visqueen on beam) A bond breaker reduces the design capacity. Form release agents are also bond breakers and must not be applied to the beams or rebar.

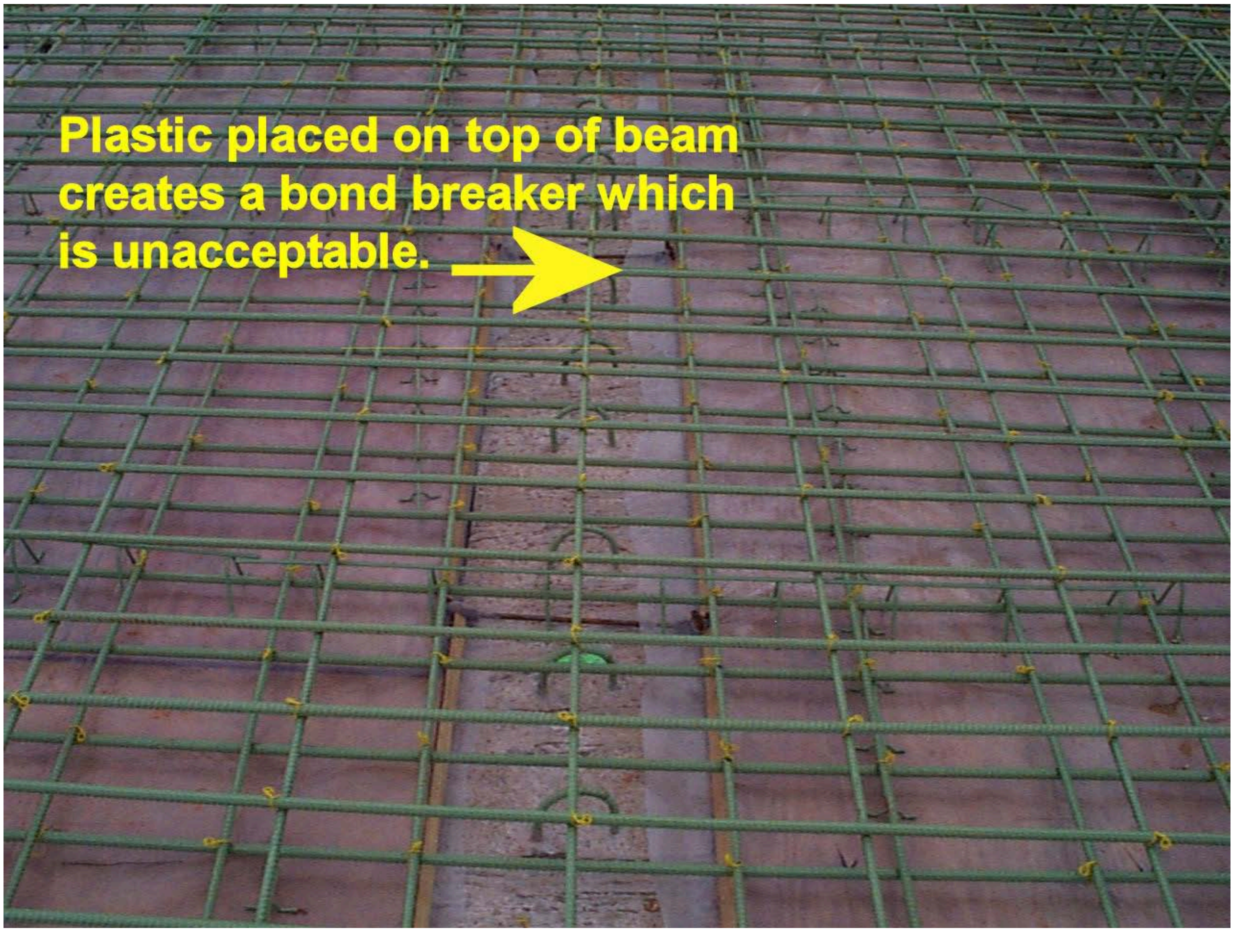


Figure 502:4. Photo. Unacceptable Creation of a Bond Breaker Resulting from Visqueen Application

Ensure that panels are placed in accordance with Section 502.02.B(2) of the Standard Specifications.

Discuss placement rates for the form design with the Contractor. For columns, abutments, walls, and other vertical elements, form designs generally are not strong enough to contain the entire height of concrete head pressure. Therefore, concrete placement has to be timed so the concrete in the lower part of the form sets up before the top is placed. This reduces the head pressure in the bottom of the form and prevents it from budging or failing. Cold weather and retarding agents in the concrete mix slow the set and will take a slower rate of placement. However, the rate can not be so slow that it creates cold joints. The Contractor must provide concrete strength gain rates for various temperatures in their mix design to help determine this placement rate.

Form liners must be coated with compatible form release agent. Clearances must be measured from the highpoints of the form liner.

Ensure that the liner is in the appropriate location. Form liners must not extend all the way to corners. The finish may be damaged when the forms are removed with form liners in corners.

Ensure that 3/4-inch triangular fillets are on all concrete edges.

Ensure that form ties will break off at least 1 inch under the surface of the concrete.

(d) Stay-in-Place Forms

For all stay-in-place forms, ensure that the shop drawings have been approved by Bridge Division.

Stay-in-place forms must not be sprayed with form release agent.

(1) Steel

For steel forms discuss the Contractor's concrete placement sequence and ensure that the top panel in the lap will be loaded with concrete first. If the bottom panel is loaded first, it causes the lap to separate and mortar to leak, as shown in Figure 502:5. Ensure that the forms are mechanically connected along the lap at 18-inch centers. The preferred method is metal screws.

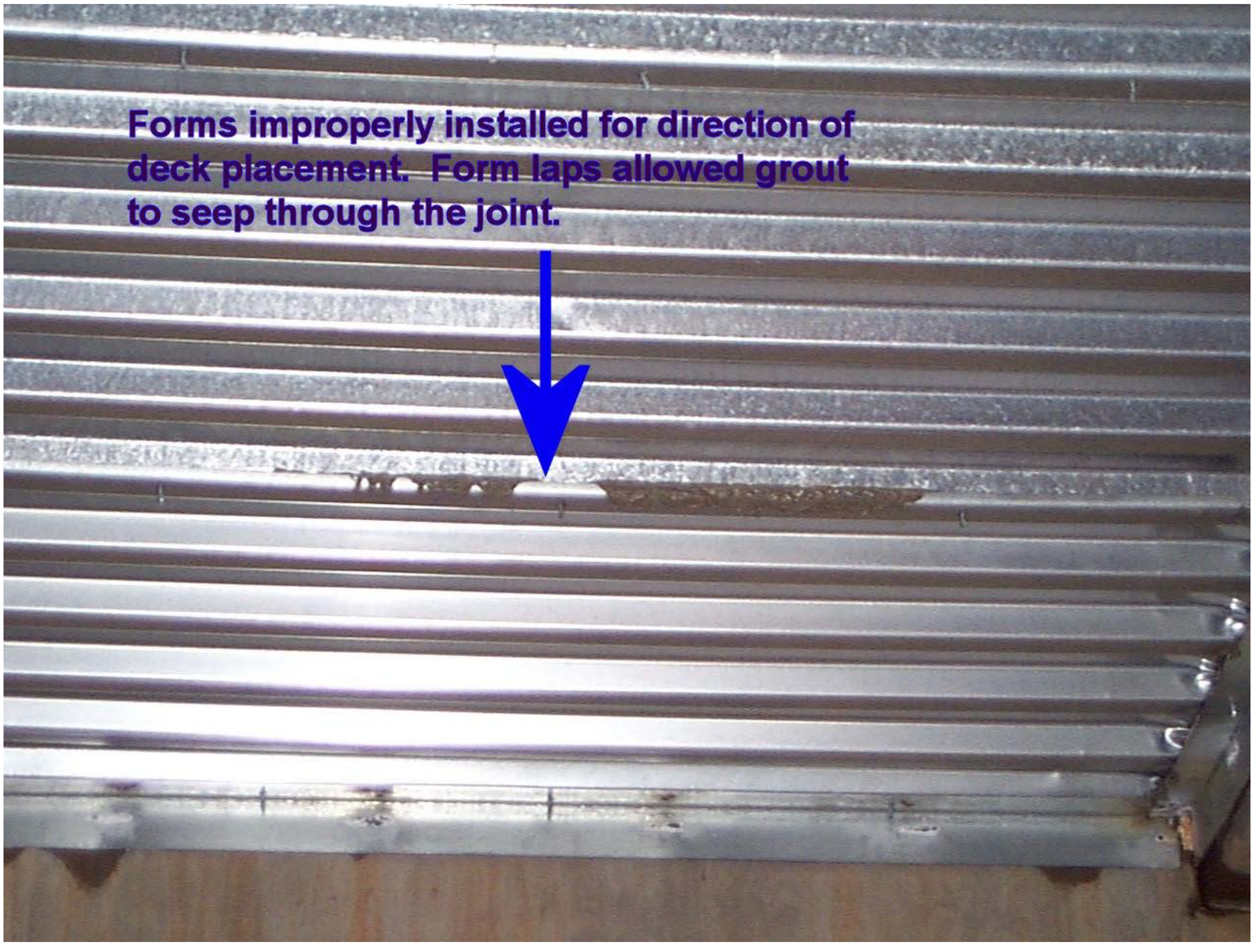


Figure 502:5. Photo. Grout Seepage Resulting from Improper Steel Form Installation

Steel forms must not be welded to steel girders. Contractors typically place a strap across the girder and weld it to channels on each side that hold the steel forms in place. See Figure 502:6 for a photo of an acceptable weld. The channels can be adjusted for the appropriate haunch depth. The forms set on the channels. Ensure that the forms have at least 1 inch of bearing at each end.

Figure 502:6. Photo. Acceptable Weld of Stay-in-Place Forms

Often the welders will weld the strap to the steel girder. It may just be a small overrun, but it can cause huge fatigue failures in the future. Ensure that the welder only welds the strap to the channel and there are no welds to the girders such as that shown in Figure 502:7. If welds are found on the girders, contact the Bridge Division for repair recommendations.

Ensure that any coating damage is repaired.

Ensure that holes are drilled through forms under construction joints.

Figure 502:7. Photo. Unacceptable Welding of Form Strap to Bridge Beam

(2) Concrete

Check concrete panels to ensure that they were inspected at the prefabrication plant. Ensure that they were not damaged in transport or during erection. Damaged panels must be replaced. It is critical that concrete from the deck placement fill the gap under the panels and over beams. If this gap is not filled completely, the panels will settle, causing the deck to crack. Ensure that there is at least 1 inch between the bottom of the panel and the top of the beam and that the design required overlap on the top of the beams is provided. The temporary support for the panels must be at the edges of the beam flanges. The temporary support must have gaps every 3 feet to allow air to escape. Monitor the gaps in the temporary forms during placement of the deck to ensure that the concrete is flowing under the panels. Adjustments must be made during the deck placement if the gaps are not filling in.

D. Safety and Environmental Considerations

Ensure that the Contractor complies with its plan to protect workers and traffic during construction. This includes:

- Providing fall protection for workers,
- Preventing tools, material etc. from falling on traffic beneath, and
- Providing traffic control during construction.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location and description of work being performed (e.g., “forming deck span #1”)
- Weather conditions or other conditions affecting the progress of or delaying prosecution of the work, equipment break downs, etc.
- Discussion of project prosecution with the Contractor that are of an unusual nature and any specific recommendations or instructions to the Contractor

2. Measurement and Payment

Documentation of these items will be performed within the SiteManager / Daily Work Reports / Work Items tab.

- Select the appropriate pay item from the list of contract pay items.

- In the appropriate field, enter either a descriptive location or the station to station extents, preferably both.

- In the Placed Quantity field, enter an estimated percentage of the lump sum item completed, ensuring that the total quantities to date does not exceed 1.00 Lump Sum.

502.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

None required.

B. Audit Requirements

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Payment for this item must equal 1.00 Lump Sum. Add link for screen shot of the Report, SSS Database, etc.

C. Protection of the Work

Confirm that removal of falsework is in compliance with Section 502.04.C of the Standard Specifications. After removing the forms, complete curing of the concrete in accordance with Section 509.04 of the Standard Specifications.

Ensure that stay-in-place forms are sounded to confirm solid concrete.

The Resident Engineer may shorten the time for form removal specified in Table 502:2 of the Standard Specifications when concrete attains 80% of design strength. The specimens for determining early strength requirements must be stored with the 'mass' concrete. They must be representative of the temperatures the concrete experiences. If the specimens are stored in a 70 degree water bath while the mass concrete has been in 50 degree weather, the rate of strength gain will be much faster in the 70 degree bath than the mass concrete. If the forms are removed based on a test like this, the concrete could fail. Maturity meters are another good way to measure in-place concrete strength gain.

Inspect exposed concrete surfaces for compliance with the tolerances specified in Section 502.04.B(1) and (2) of the Standard Specifications.

CHECKLIST – FORMS, FALSEWORK AND TEMPORARY WORKS

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Shop drawings for stay-in-place forms have been approved by the Bridge Division. [502.02.B(5)]					
Falsework working drawings have been approved by the Bridge Division. [502.02.A]					
Cantilever bracing details have been approved by the Bridge Division. [502.02.A(6)]					
Contractor is aware that the inspector must approve forms before concrete can be placed. [502.02.B(1)]					
Contractor has a plan for placing concrete at a rate that does not overstress the forms or create cold joint.					
Contractor has provisions for fall protection.					
Contractor has provisions for protecting traffic from falling objects.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Removable Forms:					
Plywood for exposed surfaces is Exterior B-B Class-1 grade. [502.02.B(2)]					
Form panels are at least 3ft (1m) wide and 6ft (2m) long. [502.04.B)(2)]					
Forms are mortar-tight and of sufficient strength to prevent deflection. [502.04.B]					
Forms are on line and grade with adjustments for settlement and within the tolerances of Table 502:1.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Formed corners have 3/4 in (20mm) triangular fillets (chamfers). [502.04.B(2)]					
Forms are cleaned and oiled. [502.04.B(2)]					
Forms provide 6 in (150 mm) to pile face for pile capped below finished ground surface. [514.04.C(3)]					
Forms provide 4 in (100mm) to pile face from any pier cap face. [514.04.C(3)]					
Form ties can be removed to at least 1 in (25mm) depth without damaging concrete. [502.04.B(2)]					
Stay-in-Place Forms:					
Forms have 1 inch (25mm) of bearing area on form supports. [502.04.B(4)]					
Form supports are attached to beam using bolts. clamps, or approved methods and are **not welded to beam flanges** or reinforcing. [502.04.B(4)]					
Any damaged galvanizing has been touched up. [502.04.B(4)]					
Form laps have been connected by means other than welding. [502.04.B(4)]					
Top panel in the laps will be loaded first. [502.04.B(4)]					
Transverse construction joints are located in bottom of flute and have 1/4 inch (6mm) weep holes been drilled at 12 inch (300mm) centers along line of joint. [502.04 B(4)]					
Decks:					
Exterior girders are braced to prevent rotation. [504.04.A(6)]					
Beams are clean with no form oil or visqueen on them. [502.04A(6) & B]					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Tell-tales are in place and marked. [502.04.A(7)]					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
If forms are removed before cure period is complete, Contractor continues to cure them? [509.04.F]					
Exposed surfaces meet the plan line and grade within the tolerances of Table 502:1.					
After concrete is placed, forms have been sounded with a hammer and unsound areas investigated. [502.04.B(4)]					

SECTION 503 – PRESTRESSED CONCRETE BRIDGE MEMBERS

503.01 GENERAL

This work consists of providing and placing precast, prestressed beams and other precast concrete bridge components in the bridge structure.

503.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Contractor to provide source of prestressed members.
- Contractor to submit shop drawings to ODOT.
- Contractor to submit source for IZ-E-U paint system.

B. Acceptance of Materials

Confirm that the proposed source of prestressed members is on the Materials Division Approved Product List (APL). If the proposed source is not on the APL, contact Materials Division for source approval. Inspection at the fabrication plant site will be handled by Materials Division or its representative. Residency personnel are not required to perform fabrication inspection.

Acceptance at the fabricator's facility, denoted by an inspection stamp, does not prevent subsequent rejection. The Resident Engineer may reject materials not meeting Contract specifications and prestressed members damaged during delivery or by improper handling. The Contractor shall immediately replace or correct rejected materials and work.

C. Preparatory Work and Contractor Work Plans

1. Required Documents

Records must be on file for the following items:

- Shop-inspected prestressed members will be documented by a "Summary Report for Beams."
- Approval of each kind of paint field applied.
- Elastomeric bearings accepted by "Neoprene Bearing Pad Test Report."
- The fabricator or Contractor approved shop drawings, including any special erection procedures.

2. Check of Bearing Seats

A final check must be made of the elevation of bearing seats on the piers and abutments before erection of prestressed members is scheduled to begin. If bearing seats are found that need correction, it must be performed in the manner and to the tolerances described in the Section entitled "Girder Bearing Surfaces" in Section 509.04.K of the Standard Specifications.

Verify that beveled bearing plates are correctly oriented prior to erection and that the Contractor has addressed any temperature corrections indicated in the Plans.

Verify distance between anchor bolts / bearing assemblies.

D. Safety and Environmental Issues

None required.

503.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

Prestressed members are inspected by Materials Division or its representative during fabrication and are stamped with markings to indicate compliance with specifications prior to shipment. The Residency Project Inspector must complete the material test template for acceptance of this item. [Document in Template AM5002].

Acceptance at the fabricator's facility, denoted by an inspection stamp, does not prevent subsequent rejection. The Engineer may reject prestressed members not meeting Contract specifications, or which have been damaged during delivery or installation. The contractor will immediately replace or correct rejected materials and work.

Ensure that the IZ-E-U paint system used by the Contractor to coat any exposed steel items is on the ODOT Approved Products List in accordance with Section 507 of this Manual.

B. Equipment and Methods

Ensure that the Contractor's proposed methods for preparation and painting of exposed steel items are in compliance with Section 512 of the Standard Specifications.

C. Construction Operations

1. Field Inspection

When prestressed members arrive on the site, inspect them for damage and quality of fabrication as thoroughly as time and conditions allow. Verify that the prestressed members have been stamped with acceptable ODOT inspection markings. If the member has been stamped with '105.03,' there may be special conditions for its use that must be verified prior to erection. Do not accept un-stamped members. Inspection must include areas that look like they were patched and cracking. Fine cracking at the ends of the beams, whether box beams or I beams, is not unusual and will tighten under erection and dead loading of the members. Large cracks or cracking in other locations is not usual or acceptable.

Embedded components for prestressed concrete beam members (e.g., weld plates, inserts, hangers, etc) will be considered included under and covered by the "Summary Report for Beams."

All non-embedded components for prestressed concrete beam members (e.g., bearing plates, diaphragm rods, anchor bolts and nuts, etc) will not be considered included under and covered by the beam inspection; they are to be provided by the steel fabricator with separate certification documentation.

2. Damage or Corrective Actions

Note and report to the Resident Engineer the nature and extent of any damage that may have occurred due to loading, transit, or unloading, along with the identifying piece mark of the member. If the need for corrective work is obvious, advise the Contractor immediately so that the responsible party will be notified and correction can be performed in the most advantageous location. Do not allow the Contractor to drill any holes in prestressed members or make any repairs or corrections without approval of the Bridge Division.

3. Storage

The preferred location of storage for prestressed members is at the fabricator's facility. However, if prestressed members are stored onsite, ensure that they are supported off the ground on blocking at their design bearing points. Ensure that members are stored in a true vertical position. When prestressed members are stored onsite, they must be placed on a North to South alignment to minimize sweep changes.

4. Sweep

The sweep (horizontal curvature) of the prestressed concrete member was inspected within two days prior to shipment and will not need to be checked at the jobsite unless the member was placed in temporary storage at the site. If the member was stored onsite, the specified tolerance for sweep or horizontal curvature of a prestressed beam is 1/8 inch for every 10 feet of length. If sweep is measured in the field, do so as early in the morning as possible, to minimize the effect of temperature variations. If assistance is required, contact the Materials Division.

5. Camber

The camber (vertical curvature) of the individual prestressed concrete member was inspected within two days prior to shipment if a design camber was specified and will not need to be checked at the jobsite. The side by side differential camber between adjacent beams is not checked by the prestressed concrete inspector prior to shipment as the members are not installed in their final position. The side-by-side differential camber between beams is ±1/8 inch for every 10 feet of length. If this condition is discovered, contact Bridge Division.

D. Safety and Environmental Considerations

Ensure that the Contractor complies with its plan to protect workers and traffic during construction. This includes:

- Providing fall protection for workers,
- Preventing tools, material etc. from falling on traffic beneath, and
- Providing traffic control during construction.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location of prestressed members erected (span number, beam line, etc)
- Any conditions requiring corrective actions, individual contacted, and their recommendations
- The party performing the corrective actions

2. Measurement and Payment

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

(a) Linear Foot Unit of Measure Pay Items

Documentation of these items will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template, or within the SiteManager / Daily Work Reports / Work Items tab.

1. When utilizing the DWR Template document as follows:

    a. Select the appropriate pay item from the list of contract pay items.

    b. Open the ‘DWR Templates’ icon in the toolbar.

    c. Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to be used as the method of documentation for the work performed.

d. In the appropriate field, enter the descriptive location (i.e. Bridge 'A' – Span #1 – Beam #3) or the station to station extents and location.

e. If the actual beam length is different than the Station Length, place that measurement in the Measured Length field, and an explanation is required in the Remarks field.

f. For additional areas or additional locations, with different dimensions, select the 'New Row' button.

2. When utilizing the DWR Work Items Tab document as follows:

   a. Select the appropriate pay item from the list of contract pay items.

   b. In the appropriate field, enter the descriptive location (i.e. Bridge 'A' – Span #1 – Beam #3) or the station to station extents and location.

   c. In the Placed Quantity field enter the linear foot of beam complete in place as shown on the plans.

(b) Square Foot Unit of Measure Pay Items (Prestressed Concrete Deck Panels)

Documentation of this Square Foot item will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template, or within the SiteManager / Daily Work Reports / Work Items tab.

1. When utilizing the DWR Template document as follows:

   a. Select the Prestressed Concrete Deck Panels from the list of contract pay items.

   b. Open the 'DWR Templates' icon in the toolbar.

   c. Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to be used as the method of documentation for the work performed.

   d. Select the appropriate method of measurement from the Type radio button options. Depending on the option selected, enter the following information:

(1) Two Dimensional Measured Quantity Option.

This option can be used to allow the template to calculate areas for progressive payments or for documenting the final quantity. Typically this option will be used for areas involving simple calculations which will only require length and width.

- In the appropriate field, enter the descriptive location (i.e. Bridge ‘A’ – Span #1) or the station to station extents and location.
- Input the measured length and width to calculate an area.
- If the actual panel length is different than the Station Length, place that measurement in the Measured Length field, and an explanation is required in the Remarks field.
- For additional areas or additional locations, with different dimensions, select the ‘New Row’ button.

(2) Calculated Quantity Option.

This option will allow the input of quantities calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), and can be used for progressive payments or for documenting the final quantity of areas. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

- In the appropriate field, enter the descriptive location (i.e. Bridge ‘A’ – Span #1) or the station to station extents and location.
- In the Placed Quantity field, enter the calculated quantity (SF) of the item completed.
- In the Book/Folder/Envelope # field provide the location of the documentation for the calculations.
- For additional areas or additional locations, with different dimensions, select the ‘New Row’ button.

2. When utilizing the DWR Work Items Tab document as follows:

a. Select the Prestressed Concrete Deck Panels from the list of contract pay items.

b. In the appropriate field, enter the descriptive location (i.e. Bridge 'A' – Span #1) or the station to station extents and location.

c. In the Placed Quantity field enter the square foot of panel complete in place as shown on the plans.

(c) Documentation Procedures for the Prestressed Concrete Bridge Members Pay Items

(1) Prestressed Concrete Beams (LF)

This pay item will be documented utilizing the DWR template for Linear Foot (LFT) or the DWR Work Items tab.

(2) Prestressed Concrete Double Tees (LF)

This pay item will be documented utilizing the DWR template for Linear Foot (LFT) or the DWR Work Items tab.

(3) Prestressed Concrete Deck Panels (SF)

This pay item will be documented utilizing the DWR template for Square Foot (SqFt) or the DWR Work Items tab.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

(d) Reduced Payment for out of tolerance Prestressed Concrete Bridge Members

If out of tolerance members are produced and identified by the Materials Division, the Bridge Division will evaluate whether or not the member may be used in the structure. If the member is determined to be structurally sufficient, Bridge Division will send a memo to the Resident Engineer recommending acceptance in accordance with section 105.03 of the standard specifications.

Payment for these members will be made under the original contract item, and a deduction will be applied and documented by change order.

The following table should be used for reference purposes only when calculating deductions for prestressed concrete bridge beams which fail to meet specification requirements, but may be accepted in accordance with section 105.03 of the Standard Specifications. This table is to be utilized only after Bridge Division has identified a deficiency and written a letter authorizing the acceptance of the beam in question; and only after the Resident Engineer has agreed to the conditions under which the beam will be accepted and allowed to remain in place.

Deduction Guidelines for Out-of-Specification Prestressed Concrete Bridge Beams

Deficiency		Deduction per Beam
Concrete strength		$100 + [(total contract price for each beam) x (1.00 - the strength pay factor determined by using the formula below) x (0.55)]
Concrete air content		$100 + [(total contract price for each beam) x (1.00 - the air content pay factor determined by using the table below) x (0.55)]
Diaphragm holes		$100, unless a plate is added, then $600
Strands over or under stressed		$600
Strand location		$600
Too many strands		$600
Tipping / flushness of sole plate		$600
Spalling / Honeycomb		$600
Cracking		$200
Width		$100
Length		$100
Sweep		$100
K5 bars bent with heat		$100
Shear bars (D, Z or U) insufficient number, too short or out of alignment		$100
K7A, K 7B, H bars are too short		$100
Pour line (looks like cold joint)		$100
Vibrator head lost in beam		$100
Weld plates missing / on wrong end of beam		$100
Incorrect grade of steel in sole plates		$100

If a single beam has more than one deficiency, a deduction will be imposed for each defect.

In addition to the above deductions, $100 for each different type of deficiency will be charged for engineering and administrative services provided by Bridge and /or Materials Division, and $300 will be charged for processing the change order required to accept the beams.

If you encounter a beam with a deficiency other than those listed above, contact Construction Division for assistance.

In the strength and air content deduction calculations, the 0.55 value represents the average cost of the beam for the contractor compared to the unit price in the contract. This includes the material and labor only.

Low Strength Pay Factor = $(\text{Actual Strength}/\text{Specified Strength})^2$

(Section 509.06 of the 2009 Standard Specifications)

Table 509:6

Air Content Pay Factor

Below Target, % Air	Pay Factor
>0.0 – ≤1.5	1
>1.6 – ≤3.0	(1.33 x Actual Air %) / (Target Air %)
>3.0	Unacceptable

(Table 509:6 of the 2009 Standard Specifications)

Examples:

1) 32 beams with the incorrect grade of steel for the sole plates. $3,200 ($100/beam) for sole plates; $100 for engineering (same problem 32 times); and $300 for change order. $3,600 total.

2) 1 beam with spalling, cracking and diaphragm hole out of place (no plate). $700 for spalling ($600 deduction + $100 engineering); $300 for cracking ($200 deduction + $100 engineering); $200 for diaphragm hole ($100 deduction + $100 engineering); and $300 for change order. $1,500 total.

Note: This table is to be utilized for reference purposes only when calculating deductions for prestressed concrete bridge beams which fail to meet specification requirements, but may be accepted in accordance with section 105.03 of the Standard Specifications. This table is to be utilized only after Bridge Division has identified a deficiency and written a letter authorizing the acceptance of the beam in question; and only after the Resident Engineer has agreed to the conditions under which the beam will be accepted and allowed to remain in place.

O.D.O.T. Construction Division August 28, 2009

503.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

None required.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work

Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

Ensure that the Contractor completes diaphragm construction in a timely manner or takes appropriate action to brace the beams and prevent movement.

Obtain survey of haunch grades for use in Section 504 of this Manual.

CHECKLIST – PRESTRESSED CONCRETE BRIDGE MEMBERS

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Contractor has identified its sources of materials.					
Contractor has submitted shop drawings.					
Contractor has submitted its source of IZ-E-U paint system.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Bearing seats elevations meet the tolerances in Section 509.					
Beveled bearing plates have the correct orientation.					
Distance between bearing assemblies has been verified.					
Beams are stamped with markings indicating compliance with the specifications.					
If beams are stamped accepted under 105.03, verify any special condition for their use.					
The AM5002 materials test template has been completed.					
Beams are free of damage that may have occurred during transport.					
Beams are handled from lifting hoops.					
Bridge Division has approved any corrective action to beams.					
All workers walking beams use fall protection?					
Traffic is protected from falling material, tools, etc.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Contractor has braced the beams or otherwise completed diaphragm construction in a timely manner (within a day or two).					
Beams have been surveyed.					

SECTION 504 – BRIDGE DECKS, APPROACHES, RAILS AND PARAPETS

504.01 GENERAL

This work consists of constructing concrete bridge decks, approach slabs, and railings and parapets for bridges, roadways, wing walls, retaining walls, and other structures.

504.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

The Contractor shall submit its Bridge Deck Plan in compliance with Section 504.04.A of the Standard Specifications.

Discuss the Contractor's source of materials and concrete mix designs in accordance with Section 701.01.C of the Standard Specifications.

If the Contract includes the QC/QA Special Provision for bridge deck acceptance, the Contractor must submit its Quality Control Plan. Discuss with the Contractor the need to follow the requirements established in this Special Provision.

If the Contract includes the Smoothness Special Provision for bridge decks, discuss with the Contractor the need to follow the requirements established in this Special Provision, including who will be performing the testing. The smoothness testing must be performed by technician(s) certified by the Oklahoma Highway Construction Materials Technician Certification Board (OHCMTCB). The testing equipment used must also be certified by the OHCMTCB.

Do not allow the Contractor to place deck concrete until a pre-deck pour inspection is held and approved by the Resident Engineer.

B. Acceptance of Materials

1. Concrete Mix Design

For structural concrete, the Contractor will submit its proposed concrete mix designs. The Resident Engineer will approve the concrete mix design in accordance with Section 701.01.C of the Standard Specifications or as amended by the QC/QA Special Provision for bridge deck acceptance, if applicable. As soon as practical, the Residency will obtain sufficient samples of the aggregates to be used and perform applicable tests on these materials.

2. Concrete Plants

The Resident Engineer will inspect and certify the proposed concrete plant in accordance with Section 414.03.A of the Standard Specifications and will submit this information to the Materials Division. If a portable plant is mobilized to the

Project, the Resident Engineer must notify the Oklahoma Department of Environmental Quality (ODEQ) and the Materials Division. The purpose of such notice is to ensure that the plant(s) are properly permitted and inspected for emissions by ODEQ, and that they are accurately tracked within ODOT's databases. When a plant is being installed to produce for a Project in your Residency notify:

Oklahoma Department of Environmental Quality
Air Quality Division
P.O. Box 1677
Oklahoma City, OK 73101-1677
Phone: (405) 702-4100
Fax: (405) 702-4101

and

Oklahoma Department of Transportation
Materials Division
Independent Assurance Branch
200 N. E. 21st Street
Oklahoma City, OK 73105
Phone: (405) 521-2677
Fax: (405) 522-0552

In the notice, list the project number and the location and type of plant (concrete or asphalt).

3. Sources of Materials

The Contractor will submit its proposed sources of materials and metal fabricators. The Resident Engineer will verify that the proposed sources of materials and metal fabricators are on the Approved Products List (APL). If a proposed source or fabricator is not on the APL, contact the Materials Division immediately. Verify the APL for the following:

- Structural Concrete – source for each individual component, in accordance with Section 509 of this Manual
- Joint Fillers and Sealers
- Reinforcing Steel
- Curing Materials
- Metal Beam Railing – Structural Steel Category
- Aluminum Alloy Tubes for Railings - Structural Steel Category
- Cast Aluminum Alloy Bridge Railing Posts - Structural Steel Category
- Pipe Railing – Structural Steel Category
- Expansion Joint - Structural Steel Category

C. Preparatory Work and Contractor Work Plans

At the Preconstruction Meeting, the Contractor shall submit to the Resident Engineer for approval, a Bridge Deck Plan in accordance with Section 504.04.A of the Standard Specifications that covers the following:

- Falsework, forming, and bracing details.
- Stay-in-place form shop drawings, lap details, methods for sealing corrugations, and method of attachment to beams.
- Placing, consolidating, finishing, fogging, and curing equipment and back-up equipment located on-site.
- Quantities of material and numbers of equipment for rainy, cold, and hot weather protection.
- Concrete mix design, the plant supplying the concrete, and the expected delivery and placement time.
- Quality control plan for concrete placement that includes the purpose, intent, and interpretation of the QC specifications, if applicable.
- Identification of checks used to ensure the deck conforms to the dimensions shown on the Plans and quality required by the Contract.
- Process for delivering, placing, consolidating, finishing, and curing the concrete.

Obtain survey of beam haunch elevations for calculation of finished deck form grades. Survey should not be performed more than 30 days prior to placement of the concrete in the deck, in the event there is continued creep in the beam haunch. The as-built top of beam elevations will be obtained after final placement of the bridge beams either by the Contractor or the Resident Engineer. These elevations will be used to calculate the finished deck grades and the deck forms. If elevations and calculations are performed by the Contractor, the Resident Engineer must verify the accuracy of these elevations and calculations.

For projects that include the QC/QA Special Provision for bridge deck acceptance, the Contractor must have submitted their Quality Control Plan at the prework conference, and this plan must be accepted by the Resident Engineer prior to initiation of the work. Once accepted by the Resident Engineer, this plan becomes a part of the Contract, and shall be enforced accordingly. The Contractor's quality control samples and tests must be performed by technician(s) certified by the OHCMTCB. Quality control tests performed in a lab must be accomplished in a Materials Division Qualified Lab.

D. Safety and Environmental Issues

Ensure that the Contractor is aware that they will not be allowed to dispose of concrete or slurry from sawing and texturing in waterways, as discussed in the following video.

Discuss with the Contractor its plan to protect workers and traffic during construction. The plan must address:

- Fall protection for workers,

- Measures to prevent tools, material etc. from falling on traffic beneath, and
- Traffic control during construction.

504.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

1. Concrete Mix Design

Ensure that the Resident Engineer has approved the concrete mix design in accordance with Section 701.01.C of the Standard Specifications or as amended by the QC/QA Special Provision for bridge deck acceptance, if applicable. Any changes to the approved concrete mix design, including substitution of material sources, must be approved by the Resident Engineer.

2. Concrete Plants

Ensure that the concrete plant has been certified in accordance with Section 414.03.A of the Standard Specifications.

3. Sources of Materials

Ensure that the Contractor has submitted its proposed sources of materials and metal fabricators. The Residency will verify that no changes were made from the proposed sources of materials and metal fabricators and that they are still on the APL. If a proposed source or fabricator is not on the APL, the Resident Engineer must contact Materials Division immediately.

Document or perform applicable tests as follows:

- Structural Concrete – sample and test for each individual component, in accordance with Section 509 of this Manual. If amended by the QC/QA Special Provision for bridge deck acceptance, test frequencies and target values will vary.
- Joint Fillers and Sealers - ensure that they are provided from an approved source, as shown in the APL. [Document in Template AM5001]
- Reinforcing Steel – accept in accordance with Section 511 of this Manual.
- Curing Materials - ensure that they are provided from an approved source, as shown in the APL. [Document in Template AM5001]
- Metal Beam Railing – ensure that they are provided from an approved source, as shown in the APL Structural Steel Category. [Document in Template AM5002]
- Aluminum Alloy Tubes for Railings - ensure that they are provided from an approved source, as shown in the APL Structural Steel Category. [Document in Template AM5002]

- Cast Aluminum Alloy Bridge Railing Posts - ensure that they are provided from an approved source, as shown in the APL Structural Steel Category. [Document in Template AM5002]
- Pipe Railing – ensure that they are provided from an approved source, as shown in the APL Structural Steel Category. [Document in Template AM5002]
- Expansion Joint - ensure that they are provided from an approved source, as shown in the APL Structural Steel Category. [Document in Template AM5002]

The metal railings and expansion joints are inspected by Materials Division during fabrication and are stamped with markings to indicate compliance with specifications prior to shipment. Visually verify that these products are stamped with the appropriate markings.

B. Equipment and Methods

1. Finishing Machine

The Contractor must use a self-propelled finishing machine supported on rails or steel-clad headers capable of transversely finishing the bridge deck and approach slabs. Before placing concrete, the Contractor must submit a machine description that includes the make, model, a finishing plan, and an equipment breakdown plan that lists spare equipment and parts and estimates for down time. Enough equipment and labor must be available to limit down time so that concrete placement can be completed within the time requirements in Table 509:6 of the Standard Specifications.

2. Fogging Equipment

The Contractor must provide a pressurized fogging system that complies with the requirements in Section 504.03.B of the Standard Specifications.

The Contractor is not to use hand held foggers as the primary fogging equipment or as a finishing aid. These may be used in areas where supplemental fogging is required.

3. Grooving Machine

If the Contract requires saw-cut grooving, the Contractor must provide a self-propelled grooving machine equipped with the following features:

- Diamond saw blades mounted on a multi-blade arbor at the Contract required spacing,
- A depth control device that detects variations in the concrete surface and adjusts the height of the cutting head to maintain the Contract required depth,
- An alignment control device, and

- A vacuum attachment that removes and collects slurry or residue from the grooving operation.

4. Work Bridges

The Contractor must provide at least two work bridges to provide access for floating, straight edging, fogging, curing, and finishing the concrete.

C. Construction Operations

1. Pre-Deck Pour Inspection for Placing Concrete for Superstructures

Prior to the scheduled day for deck placement (preferably the day before) a conference must be held at the Project site to review the plans and preparations for the pour. The Contractor's superintendent and key personnel, together with the Resident Engineer and available inspectors who will be involved, should attend. At this time, the superintendent must state fully the Contractor's plan of operation, and the Resident Engineer and the superintendent must reach agreement on all of the following:

a. Forms are mortar tight, cleaned, and oiled. The use of visqueen is discouraged, but if the Contractor chooses to do so, ensure it is clean, tightly fit to eliminate wrinkles in the concrete (see Figure 504:1), and not overlapping onto the top surface of the beams (see Figure 502:4).

Figure 504:1. Photo. Sealing Forms with Plastic

b. Stay-in-place steel forms are lapped in the direction required by the Contract.

c. Concrete panels are set to allow concrete to flow between the bottom of the panel and the top of the beam in accordance with Section 502 of the Standard Specifications.

d. Falsework has been inspected and certified, and tell-tales installed and marked in accordance with Section 502 of the Standard Specifications. Ensure that tell-tales are placed on the overhang under the edge of the deck and in the middle of the deck to monitor differential dead load deflections.

e. For steel beam bridges, verify that the cantilever is properly braced. Bracing detail must be submitted by the Contractor for approval by Bridge Division.

f. Reinforcement is clean. The following video stresses the importance of keeping the deck as clean as possible prior to concrete placement.

g. Any coating damage to reinforcement has been repaired.

h. Reinforcement clearances and spacing meet plan dimensions and tolerances in accordance with Section 511 of the Standard Specifications. Figure 504:2 depicts inadequate cover over the reinforcing steel.

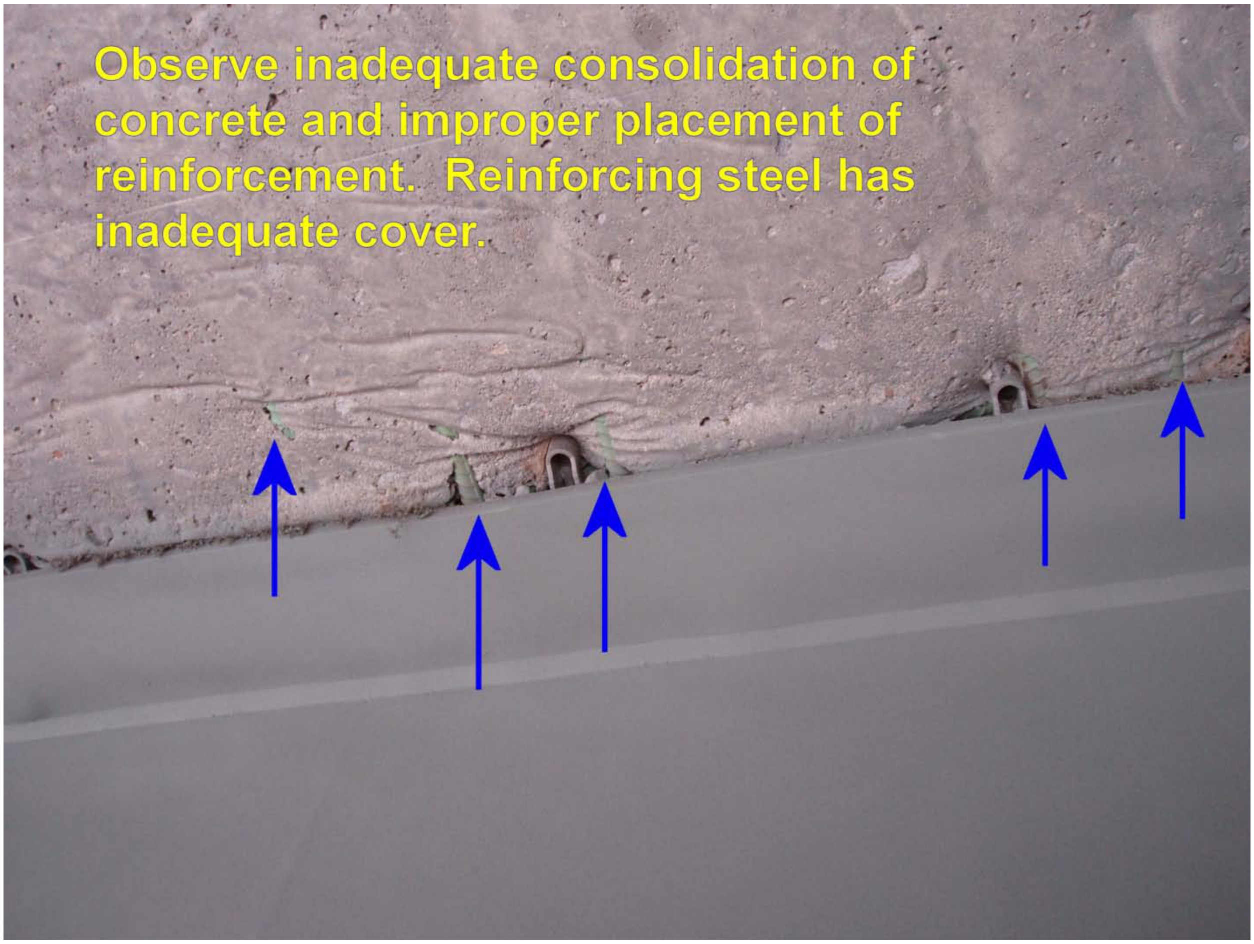


Figure 504:2. Photo. Inadequate Cover Over Reinforcing Steel

i. Reinforcement ties are tight and support provides a stable mat. The following video shows how unsupported rebar can create deflection problems.

j. Finishing machine rails are stable.

k. Back-up equipment is onsite in accordance with the Contractor's plan.

l. No oil or fuel leaks from machinery.

m. Expansion joints are supported on the plates in the beams as shown in the plan details and are set to the proper grades. In cases where there is not a plate in the ends of the beams, rigid plates on top of the joint will be required to secure the two halves of the expansion joint. The rigid plates on top of the joints should not be used if the expansion joints are supported on the plates in the beams.

n. The dry run produces cover, clearance, and deck thicknesses in accordance with Table 502:1, "Maximum Dimensional Tolerances for Cast in Place Formed Concrete" in the Standard Specifications. On skewed bridges, if the finishing machine is not parallel to the skew, park the finishing machine so the center is over the pier and check the thickness and cover over the pier and at the edges of the deck.

o. Equipment and materials for weather protection are in place in accordance with the Contractor's plan. Discuss wetting forms before concrete is placed in hot weather to help keep concrete cool. Water can not be ponded on forms when concrete is placed. Enough plastic should be onsite to cover the deck if it rains. During cold weather, discuss methods to insulate the forms to prevent concrete freezing. Be sure to place thermometers near formed surfaces in cold weather.

p. Temperature reading locations during cure period are identified in accordance with Section 509 of the Standard Specifications.

q. Work bridges, curing materials, and equipment are prepared for concrete placement. Curing material (burlap) has to be soaked to remove waxes to perform properly. It can not simply be sprayed with a hose. Fogging equipment is mounted on finishing machine and is capable of fogging the entire deck width behind the finishing operation. All nozzles work and the Contractor has a plan to replace nozzles that fail during the deck placement. The equipment can produce a semi-gloss water sheen on the surface until the application of wet burlap curing material. Discuss with the Contractor that fogging or blessing of the deck is not to be used to aid in finishing in any form. Check that there is a water source capable of handling curing quantities.

r. Curing compound application equipment provides application rate measurements.

s. The shelf life of curing compounds have not expired in accordance with Sections 504 and 509 of the Standard Specifications.

t. Identify locations for concrete discharge, sampling, and testing in accordance with Section 701.01 of the Standard Specifications.

u. Identify the proper mix design to be used and discuss quantity to be delivered compared to the estimated quantity needed. Discuss what retempering will be allowed, if any. Determine if delivery time is acceptable. If the concrete is pumped, ensure that the material to be tested is taken from the outlet end of the pump, not at the truck.

v. If the concrete is going to be pumped, discuss possible configuration of the pump hose so as to minimize vertical drop (no more than 6 feet) to help eliminate the loss of air content.

2. Inspection During Deck Concrete Placement

The Inspector should be aware of the general concrete placement issues discussed in the following video.

During the Contractor's concrete placement operations, the Inspector should perform the following inspection activities:

a. Before placement starts, check the forms and reinforcing steel one last time to ensure that no deleterious material has gotten on them. Mud on forms is a serious concern, as discussed in the following video.

b. Confirm that the temperature of any surfaces that will be in contact with the concrete (forms, rebar, steel beam flanges, expansion devices, etc) are greater than 35 degrees F and less than 100 degrees F, in accordance with Section 509.04.B of the Standard Specifications. If water is used to cool the forms, ensure that there is no ponding.

c. Check the concrete tickets, especially on the first truck, to ensure that the proportions meet the proper mix design to confirm that the concrete being delivered is Class AA, and time limits from batching to placement and finishing are not exceeded.

d. If the concrete is pumped, ensure that the material to be tested is taken from the outlet end of the pump, not at the truck.

e. Test concrete and discuss with the Contractor any adjustments that may be needed (slump, air, temperature, etc.).

f. Note any water that is added to the concrete truck on the ticket for calculation of the water cement ratio.

g. Concrete pumps usually run some grout through them before the concrete; ensure that the grout is not used in the deck.

h. Ensure that concrete is not dropped more than 6 feet. Vertical drop of the concrete, even in the pump truck hose, will have a detrimental effect on the air content of the concrete.

i. Ensure that the concrete is placed at a rate of at least 25 feet per hour measured longitudinally along the bridge deck.

j. Do not allow workers to clean rakes or other equipment by beating them on epoxy coated rebar. This will result in chipping of the epoxy coating. The following video addresses the importance of protecting epoxy-coated reinforcing steel from damage.

k. Ensure that vibrators are not drug across rebar or used to move concrete. This action may damage the epoxy coating on the reinforcing steel and will cause segregation of the coarse aggregate. Vibrators should only be inserted vertically. The following video demonstrates proper consolidation procedures.

l. Check tell-tales to ensure that deflections are according to plan and that the overhang is not deflecting more than the rest of the bridge. If the overhang is deflecting more than the rest of the bridge, this is an indication that the deck thickness may be insufficient and corrective actions should be taken immediately.

m. Observe if the finishing machine provides a smooth surface that requires little or no additional work. If excessive handwork is being required to provide a smooth surface, adjustments need to be made to the finish machine (e.g., alter angle of rollers, check pan for concrete build up, etc.).

n. NO WATER MAY BE ADDED TO THE SURFACE TO AID IN FINISHING!!!!!!

o. Ensure that fogging operations, for the entire deck width, begin immediately after concrete strike off. Ensure that the fogging nozzles atomize the water droplets without creating pools of water on the finished surface.

p. Check and document the thickness and cover of the finished deck at the edge and in the center. Check as soon as possible after commencing the deck pour and then periodically throughout the pour, especially at the middle of the span(s).

q. Monitor and document the time it takes from when the finishing machine strikes off the concrete to the placement of the first layer of wet burlap for curing and ensure that it does not exceed 10 minutes. If the finish machine is run parallel to the skew of the bridge, the wet burlap may need to be placed parallel to the skew as well to meet the time requirements.

r. Monitor the time it takes to place the second layer of wet burlap. It must be placed within 5 minutes after the first layer.

s. Ensure that placement of the wet burlap and the misting hoses are completed without damaging the concrete surface.

t. Once the concrete has cured enough to allow foot traffic, check that soaker hoses are placed on the burlap to supply water to maintain saturation.

u. Ensure that white polyethylene film is placed over soaker hoses and burlap.

v. During cold weather placement, ensure temperature measuring devices are placed in accordance with the Contractor's pre-deck pour plan to confirm that the concrete surface temperature does not drop below 50 degrees Fahrenheit for the time period required by Section 509.04.B of the Standard Specifications.

3. Inspection After Placement of Deck Concrete

The Inspector should perform the following inspection activities after the Contractor has completed the placement of deck concrete.

a. Ensure that the Contractor continuously water cures the concrete for at least 7 calendar days. If more than 10 percent of the portland cement weight consists of pozzolans (fly ash, etc.), the concrete must be cured continuously for at least 10 calendar days.

b. Ensure the white polyethylene is secure and that burlap stays continually wet during the curing period.

c. Ensure that there is enough water to maintain curing during the curing period.

d. Check and document the surface temperature of the deck to ensure that the temperature does not drop below 50 degrees F.

e. Ensure that curing compound is applied within 30 minutes of removing wet burlap. Monitor the application rate, which must be at least 1 gallon per 200 square feet. The curing compound must be applied uniformly and should look like a piece of white paper.

f. If the expansion joint assembly has rigid connections between their opposite halves, be sure that these connections are cut after the initial concrete set to prevent damage from joint movement due to thermal changes in the superstructure.

g. Ensure that the Contractor maintains wet cure even while work is being performed on the deck, such as tying steel and setting forms for bridge rails.

4. Miscellaneous

(a) Deck Closure Pour

Be sure that the Contractor follows the pouring sequence indicated in the plans. Any deviation from this sequence must be approved by Bridge Division.

(b) Setting the Grade for Finishing the Deck

When finishing a deck, setting the grade correctly is paramount for placing a deck on profile grade.

Elevations must be taken within 30 days of the deck pour on the ends of the beams and at enough points (usually 10^{th} points) on the beams to set the grade of the finish machine rail. This is done so that deviations in the camber of the beams or girders can be adjusted when setting the forms, and not later when it would be more difficult.

Deviations in the camber of the beams or girder must be corrected by varying the size of the haunch or fill over the beams. The height of the haunch or fill is determined by subtracting the elevation of the top of the beams from the theoretical elevation of the bottom of the deck.

In the case where the beams or girders have excessive camber and it would cause the beam or girder to interfere with the deck thickness, the profile grade should be raised. The new grade should parallel the plan profile as nearly as possible and provide the required deck thickness at points of maximum camber. This will result in increasing the haunch height over the piers and abutments to an acceptable level. The haunch height should be in the range of -1/2 inch to +5 inches. If the haunch is less than -1/2 inch, then as stated above, the deck thickness will be reduced and the profile should be adjusted. If the haunch height exceeds 5 inches, it may be necessary to reinforce the haunch. If the shear connectors or stirrups do not extend into the deck a minimum of 2 inches, reinforcing will have to be added. Contact Bridge Division for recommendations.

Whenever the profile grade of the deck is adjusted, this must be considered when setting the grade for the approach slabs and pavement in order to obtain a smooth transition. Even if it has not been necessary to adjust the grade, the as-built grade of the deck should be used to establish the grade of the approach slabs and pavement, since the actual dead load deflections may vary from the calculated deflections shown on the Plans.

(c) Machine Finishing

A machine finish is required. The Contractor must submit details of the method of supporting the machine on the deck and the complete procedure for placing the slab to the Resident Engineer for review. Supports for the riding rails must be adequate for the weight of the machine to avoid failure or any vertical deflection. The concrete handling, placing, and finishing procedure must be planned so that the concrete will be placed and struck off with a minimum of manipulation and at a sufficient rate to provide workable concrete in an area adequate for proper final hand finishing.

For transverse machines, the screed should be assembled or adjusted to the required crown established from a taut line while suspended in the same manner as it will be in operation.

Prior to the ordering of concrete and after the finishing machine has been made ready, make a dry run over the entire deck. Check slab thickness and reinforcing steel cover along with crown conformance to construction and expansion joints. Record in the Project records the plan dimensions for deck thickness and reinforcing steel cover as verified during the dry run. A pre-pour check that form dimensions and reinforcement have been verified and documented should be made at this time on the Inspector's Daily Report.

Although proper measurements made during the dry run should ensure plan dimensions, check measurements after the concrete is struck to grade to verify that the machine is still in adjustment and reinforcing steel remains in place. Slab thickness measurements can readily be obtained by probing with a 1/4-inch straight wire and the cover over re-steel with a 90 degree bent wire of the same size. These measurements should be made soon after the start of the finishing operation and periodically thereafter or when an area appears questionable. Wide flat sections such as super elevated slopes are questionable and must be checked. The probing should be performed in plastic concrete where the void will be more easily closed.

Some cover checks are required. However, they need not be as numerous as the depth checks that also reflect cover. It is recommended that as many depth checks be made as available time permits. A statement that check measurements have been made and conform to plan dimensions should be entered in the Project records. If localized areas do not conform to plan dimensions, these should be noted and any corrective action documented.

During operation, a uniform head of concrete should be maintained along the full length of the screed. If an excessive amount of concrete is being moved by the screed, adjustments should be made to reduce the amount of head being carried by the screed. The finish machine should produce a smooth, consistent finish that will require minimal hand finishing. If this is not occurring, adjustments need to be made to the screed. During operation, only the operator is permitted on the machine. The machine should be in operation as continually as practical, and the concrete placing procedure should not exceed the speed of the machine.

Tracking or walking in the screeded surface is not to be tolerated.

(d) Skewed Structure Requirements

Although not required by specification, it is recommended that the finishing machine be adjusted to match the skew angle. For structures with a skew angle greater than 15 degrees, the Contractor should orient the finishing machine and load the concrete on the deck within 5 degrees of the skew angle of the structure. The concrete should not be loaded more than 10 feet ahead of the finishing machine.

If the Contractor elects to place the finishing machine perpendicular to the centerline, verify the thickness during the pre-pour check over the pier and at the edge of the deck, and that the tie-in to the expansion joints and construction joints is acceptable along the entire length of the joint.

(e) Emergencies

During deck placement, unexpected difficulties may occur, such as a sudden rain shower, a breakdown in the concrete plant or the finishing machine, or other unforeseen interruptions.

(1) Rain Showers

When a shower occurs, no manipulation of concrete should be performed other than channeling the concrete that was last deposited so that water will not pond on the concrete and run back on the finished or partially finished surface. The finished surface must be covered with the curing material as rapidly as possible. Unfinished surfaces must be covered with polyethylene sheeting. After the shower, all ponded water must be removed from the concrete and out through the forms before resuming placing and finishing operations. The last surface covered with the curing material should be inspected; if it has been marred, the finish should be restored.

(2) Equipment Breakdowns

Investigate breakdowns immediately. If indications are that concrete placing operations will not resume in sufficient time, a bulkhead must be placed immediately. If practical, the location should not be over a pier. The emergency bulkhead may consist of a wood strip laid across the top of the longitudinal reinforcing bars. This strip should be as deep as the plan cover (usually 2.5 inches). Kickers can be used to secure the strip or shims inserted between the bars to obtain proper crown and grade. The concrete below the wood strip should be compacted to about a 45-degree slope; all excess concrete should be removed as far from the joint as possible and disposed of before it hardens. After the concrete has set, but can still fracture easily, the bottom edge should be broken to provide a vertical face below the bottom reinforcing steel. This may be accomplished with a pry bar prying up from the forms, but the Contractor should take care not damage the surface of the forms. If it becomes necessary to construct an emergency bulkhead, notify the Bridge Division to determine any further actions that may be required by the Contractor.

5. Finishing and Curing

The Inspector should be aware of the general concrete finishing issues discussed below and in the following video.

Providing the proper cure for a bridge deck has one of the highest impacts to longevity and performance of the deck, and it is one of the hardest things to perform correctly. It is important to keep the water that is in the concrete from evaporating. Allowing water in the concrete to evaporate increases the rate of shrinkage and is the highest cause of deck cracking. However, it is also critical to avoid adding water to the concrete, because this increases the water cement ratio and reduces the strength, which also leads to poor performance. A common practice that adds water to the concrete is for the concrete finisher to splash water on the deck (blessing) or concentrate the fog from the curing operation in an area to aid in the finishing of the deck. The finisher rubs the water into the surface of the concrete, which increases the water cement ratio substantially on the surface. This decreases the strength of the surface concrete and leads to a failure called scaling. This is where the surface concrete turns to powder, is removed by traffic, and exposes the aggregate. The best way to avoid adding water to the surface while minimizing evaporation is to fog the concrete surface from strike off until the wet burlap is placed. Any finish after the strike off should be kept to a minimum. The fog increases the humidity at the surface and reduces the air's ability to evaporate water from the concrete. As long as there is no buildup of water on the surface and no one rubs the water into the surface, the deck should perform well.

In summary, the Contractor must fog all bridge deck placements. Water from fogging should not be used as an aid to finish the concrete. Until application of the wet burlap, fogging must be continued to produce a semi-gloss water sheen on the entire surface. The concrete must be water cured in accordance with Section 504.04.E(5) of the Standard Specifications.

Based on the above, the Inspector should monitor the Contractor's operations and perform the following actions:

a. Ensure that concrete finishers are not blessing the deck.

b. If finishers have to do very much work after the initial strike off, check the adjustment on the strike off machine to reduce or eliminate this work.

c. Make sure the fogging equipment is fogging the entire exposed surface of the concrete until the burlap is placed. Do not allow the Contractor to concentrate the fogging anywhere.

d. Have the Contractor repair any clogged fogging nozzles or any nozzles or pipes that drip water on the surface.

e. Make sure the burlap is placed as quickly as possible.

f. Make sure the burlap is at least damp when it is placed. If it is dry it will suck water out of the concrete.

g. The burlap should be soaked the day before the deck placement. Burlap has wax on it and will resist holding water. Soaking it removes the wax. Even if the burlap was soaked the day before, ensure that it is still saturated when applied, as addressed in the following video.

h. Monitor the cure during the cure period. Make sure the entire deck stays wet for the entire cure period. If the plastic blows off and exposes the burlap it will dry out areas. Have the Contractor repair the plastic immediately. The following video shows the importance of fully securing all sections of curing blankets. Ensure that the soaker hoses run constantly and keep the entire deck wet for the entire cure period. Make sure the Contractor has plenty of water, the hoses are on constantly, and the entire deck is being soaked.

i. When it is necessary to work on concrete during the curing period, such as placing deck concrete adjacent to a construction joint, ensure that only that area immediately adjacent to the joint is exposed and the remaining area is protected from damage by the workers. Plywood sheets may be used for protection. The exposed area must be kept moistened until adjacent work is completed; after that the cover must be restored and normal cure resumed.

j. Ensure that floor forms used to cure the underside of the slab are not removed before the end of the curing period.

k. Inspect white polyethylene prior to use to ensure that it is sound and will retain the moisture required to cure the concrete. All holes and tears must be repaired so that they are watertight. The material should be rejected if defects are numerous and repairs are questionable, or if the plastic has cracked from aging. The white polyethylene film should be placed over the soaker hoses covering the concrete surface. The Contractor should use the widest available sheets and overlap adjacent sheets at least 6 inches. A pressure sensitive tape, mastic, glue, or other adhesive approved by the Resident Engineer must be used to tightly seal and form a waterproof cover. Ensure that the polyethylene film is secure enough to prevent displacement by the wind. Direct the Contractor to repair or replace sheet portions that become damaged before the end of the curing period, or lose waterproofing ability.

l. Ensure that the curing compound is applied within 30 minutes after completion of the water cure and removal of the wet burlap. The curing compound must be applied uniformly and should look like a piece of white paper.

m. The membrane should be applied in one or more separate coats by spraying as a fine mist, at a uniform application rate of one gallon per 200 square feet of surface. The rate of application is controlled by laying out in advance, on the surface to be cured, an area that will be properly covered by the number of gallons of compound in the spray container. The procedure helps ensure that the membrane is applied at not less than the required rate.

n. The curing membrane must be protected for at least 7 days. Direct the Contractor to apply an additional coat to marred areas of the membrane. If the curing membrane is continuously marred, the Resident Engineer may direct the application of wet burlap, polyethylene sheeting, or other impermeable material to ensure Contract requirements are met.

6. Texturing

The Contractor should begin grinding repairs and saw-cut grooving after the completion of the concrete curing period (7 to 10 days water cure and 7 days membrane cure). If spalling occurs, direct the Contractor to discontinue grooving and correct the cause. The grooves must be spaced in accordance with Table 504:1 of the Standard Specifications. Grooves must be no closer than 6 inches to devices such as scuppers, expansion and construction joints, and bridge rail. On skewed bridges, in order to accommodate the equipment used to saw the grooves, the grooves must be sawed from 2 inches to 2 feet from the expansion joint. This results in grooves with a staggered or stepped appearance.

Opening a structure to traffic prior to sawing grooves exposes the traveling public to a hazardous situation. Therefore, traffic must not be allowed on bridge decks until after the grooves have been sawed.

If the Plans allow another texture in lieu of saw-cut grooving, the deck surface must be textured to provide a surface satisfactory to the Resident Engineer. The texturing should take place as the pour progresses after other finishing operations have been completed. Note that if the concrete tears, or "mud balls" are produced on the surface, the Contractor needs to apply less pressure or wait a few minutes until the concrete begins to set. If an alternate method of texturing is used, it could impact the time period before placement of the burlap.

7. Approach Slabs

When approach slabs are included as a part of the bridge design, they are intended to function as a bridge deck spanning the distance from the bridge abutment to the beginning of the roadway pavement. As a result, it is designed and constructed similar to a bridge deck.

The concrete used to construct the approach is the same class as the bridge deck and must be placed, cured and textured using the same specifications as the bridge deck concrete. The Contract Plans will show the length, width and thickness of the approach slab, and will indicate the reinforcing and joint requirements. Verify that the dimensions, reinforcing and clearances are as indicated on the Plans during the dry run of the finish machine.

Whether or not approach slabs are being constructed, ensure that the Contractor is using the appropriate backfill material and is achieving the proper densities and grade. See Section 501 of this Manual for further guidelines and recommendations.

It is important that the approach slab be constructed parallel to the surface of the bridge deck to provide a smooth ride from the approach pavement to the bridge deck. To accommodate the actual dead load deflection of the deck, which may vary from the anticipated dead load deflection, the approach slabs may not be placed until after the deck has been placed. One method to check the final grade of the approach slab could be by using a string line. One end of the string line should be secured at a minimum distance of 20 to 25 feet back on the deck and stretched over the proposed approach slab with the other end attached to a grade stake marked with the proposed pavement grade. The final grade of the approach slab can then be adjusted to ensure a smooth transition.

8. Rails and Parapets

Do not allow the Contractor to proceed with construction of the rails and parapets until the time requirements in Section 504.04.H of the Standard Specifications have been met.

The concrete used to construct the rails and parapets is the same class as the bridge deck. The Contract Plans will show the dimensions of these elements, and will indicate the reinforcing and joint requirements. Verify that the dimensions, reinforcing and clearances are as indicated on the Plans.

Rail and parapet concrete must be cured in accordance with Section 509.04.F(2) or Section 509.04.F(3) of the Standard Specifications. The Contractor may use either the forms-in-place or the water curing method. The water curing method must be used on exposed surfaces. If forms are removed and finish applied before the end of the specified curing period, ensure that curing resumes for the remainder of the curing period.

The Contractor should provide a Class 2 finish for rail and parapet concrete surfaces, and shoulder curb sides in accordance with Section 509.04.G(2) of the Standard Specifications. A wooden float should be used to finish the tops of curbs.

(a) Conventional Forming

Carefully observe the forms for curbs, rails, and parapets for condition of surface, flush fit of panel joints, proper installation of chamfer strips, and visual and measured alignment and elevation. Adequate form supports must be provided that ensures proper position of concrete during and after placement. Surface grinding and rubbing does not justify use of inferior forms or lack of adequate supports.

When expansion devices are used to allow for bridge deck expansion, an equal or slightly more open space for expansion must be provided in the curb, rail, and parapet than is required for expansion devices. Where conduits cross this opening, verify clearance for expansion fittings to ensure free movement of the deck. Transverse joints may be placed in the sidewalk or curb section near the center of any span.

(b) Slipforming Parapets

Instead of conventional forming, the Contractor may slipform the parapets. This operation is accomplished with concrete that has a slump of around 1± inch.

Prior to placing the concrete, the Contractor must take additional measures to tie the reinforcing steel to prevent it from being dislocated during the slipforming operation. If these additional measures are not taken, the slipforming operation will cause the reinforcing to move out of its proper location. The Contractor must perform a dry run of the slipform machine to verify proper operation and clearances of the reinforcing steel.

Due to the low slump, some contractors will attempt to add water to the mix as it comes down the chute from the concrete truck and enters into the hopper of the slipforming machine. This is not allowed since it will result in concrete of inferior quality.

During the slipforming operation, small amounts of concrete will drop from the edge of the deck and onto the surface below the bridge. If the slipforming operation takes place directly over a traveled roadway, the Contractor must furnish all necessary platforms to protect the traffic from falling concrete. These platforms will also allow access to complete the finishing operation and facilitate inspector access.

The Contractor must take steps to ensure that the finished concrete meets the specified tolerances. These steps should include items such as adequately tying the reinforcing steel, determining the proper slump, and properly setting up the slipforming machine (including the proper rate of vibration). Failure to meet the specified tolerances could result in the rejection of the parapet.

Direct the Contractor to immediately repair any defects such as cracking, tearing, or honeycombing. Occasionally, when repairing defects, the Contractor will not completely fill the defect with concrete but will only bridge over the defect by placing the concrete on the surface of the parapet. This practice is not acceptable. The Contractor must take steps to ensure that the defect is completely filled with concrete. If defects are occurring at an excessive rate, the operations should be immediately suspended and corrective actions taken.

Normally, a small amount of hand finishing is required after the concrete has been formed. Hand finishing can be difficult due to the low slump of the concrete. To facilitate finishing the concrete, some contractors will sprinkle water or evaporation retardant onto the surface of the concrete. The use of these substances to aid in hand finishing is not allowed since it will only result in a surface that is subject to scaling in the future.

After the concrete has taken its initial set, it is important that the control joints be sawed to the plan depth into the parapet as soon as possible. Any delay in performing this operation will result in additional shrinkage cracks in the parapet.

D. Safety and Environmental Considerations

Do not allow the Contractor to dispose of concrete or slurry from sawing and texturing in waterways, as discussed in the following video.

Ensure that the Contractor complies with its plan to protect workers and traffic during construction. This includes:

- Providing fall protection for workers,
- Preventing tools, material etc. from falling on traffic beneath, and

- Providing traffic control during construction.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- When forms and reinforcing steel are placed
- When the expansion joints are set, the ambient temperature, and the measured opening of the joint
- When the pre-pour inspection occurred, who was in attendance, and any corrective actions identified
- When the deck, approach slabs, and rails/parapets are poured
- Whether or not proper curing method is being performed and any deficiencies observed and corrective actions taken
- When the texturing is performed

2. Measurement and Payment

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

(a) Square Yard Unit of Measure Pay Items

Measure the area of Approach Slabs by the top surface dimensions required by the Plans or approved by the Engineer.

Measure the area of Saw-Cut Grooving bounded by the ends of the approach slabs and the edges of the clear roadway.

Documentation of these Square Yard items will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template.

1. Select the appropriate pay item from the list of contract pay items.

2. Open the ‘DWR Templates’ icon in the toolbar.

3. Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to be used as the method of documentation for the work performed.

4. Select the appropriate method of measurement from the Type radio button options. Depending on the option selected, enter the following information:

   a. Two Dimensional Measured Quantity Option.

   This option can be used to allow the template to calculate areas for progressive payments or for documenting the final quantity. Typically this option will be used for areas involving simple calculations which will only require length and width.

      (1) In the appropriate fields, enter both a descriptive location and the station to station extents.
      (2) Input the measured length and width to calculate an area.
      (3) For additional areas or additional locations, with different dimensions, select the 'New Row' button.

   b. Calculated Quantity Option.

   This option will allow the input of quantities calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), and can be used for progressive payments or for documenting the final quantity of areas. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

      (1) In the appropriate fields, enter both a descriptive location and the station to station extents.
      (2) In the Placed Quantity field, enter the calculated quantity (SY) of the item completed.
      (3) In the Book/Folder/Envelope # field provide the location of the documentation for the calculations.
      (4) For additional areas or additional locations, with different dimensions, select the 'New Row' button.

(b) Linear Foot Unit of Measure Pay Items

Documentation of these items will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template.

1. Select the appropriate pay item from the list of contract pay items.

2. Open the 'DWR Templates' icon in the toolbar.

3. Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to

be used as the method of documentation for the work performed.

4. In the appropriate field, enter the station to station extents and a descriptive location.

5. If the actual measurement is different than the Station Length, place that measurement in the Measured Length field, and an explanation is required in the Remarks field.

6. For additional areas or additional locations, with different dimensions, select the 'New Row' button.

(c) Cubic Foot Unit of Measure Pay Item (Elastomeric Mortar)

Documentation of the Elastomeric Mortar pay item will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template.

1. Select the Elastomeric Mortar pay item from the list of contract pay items.

2. Open the 'DWR Templates' icon in the toolbar.

3. Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to be used as the method of documentation for the work performed.

4. Select the appropriate method of measurement from the Type radio button options. Depending on the option selected, enter the following information:

   a. Three Dimensional Measured Quantity Option.

   This option can be used to allow the template to calculate volumes for progressive payments or for documenting the final quantity. Typically this option will be used for volumes involving simple calculations which will only require length, width and thickness.

   (1) In the appropriate fields, enter both a descriptive location and the station to station extents.
   (2) Input the measured length, width and depth to calculate a volume.
   (3) For additional areas or additional locations, with different dimensions, select the 'New Row' button.

b. Calculated Quantity Option.

This option will allow the input of quantities calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), and can be used for progressive payments or for documenting the final quantity of volumes. Typically this option will be used for volumes involving multiple dimensions, irregular shapes, etc.

(1) In the appropriate fields, enter both a descriptive location and the station to station extents.
(2) In the Placed Quantity field, enter the calculated quantity (CY) of the item completed.
(3) In the Book/Folder/Envelope # field provide the location of the documentation for the calculations.
(4) For additional areas or additional locations, with different dimensions, select the 'New Row' button.

(d) Documentation Procedures for the Bridge Decks, Approaches, Rails, and Parapets Pay Items

(1) Approach Slab (SY)

This pay item will be documented utilizing the DWR template for Square Yard (SqYd).

(2) Saw-Cut Grooving (SY)

This pay item will be documented utilizing the DWR template for Square Yard (SqYd).

(3) Expansion Joints (LF)

This pay item will be documented utilizing the DWR template for Linear Feet (LFT).

(4) Concrete Rail (LF)

This pay item will be documented utilizing the DWR template for Linear Feet (LFT).

(5) Concrete Parapet (LF)

This pay item will be documented utilizing the DWR template for Linear Feet (LFT).

(6) Handrailing (LF)

This pay item will be documented utilizing the DWR template for Linear Feet (LFT).

(7) Rapid Cure Joint Sealant (LF)

This pay item will be documented utilizing the DWR template for Linear Feet (LFT).

(8) Elastomeric Mortar (CF)

This pay item will be documented utilizing the DWR template for Cubic Feet (CuFt).

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

504.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

Ensure that the 28-day concrete compressive strength requirements have been satisfied in accordance with Section 509 of this Manual or as amended by the QC/QA Special Provision, if applicable.

If the QC/QA Special Provision for bridge deck acceptance is included in the Contract, measurement of cracking in the bridge deck and reinforcing steel cover will be required for possible payment adjustment. The results of the air content and compressive strength testing may also result in payment adjustments.

If the Smoothness Special Provision for bridge deck and approach slab is included in the Contract, measurement of the smoothness of these elements will be required for possible payment adjustment and/or grinding.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantities paid equals the plan quantity.

C. Protection of the Work

Ensure that the Contractor complies with the curing requirements for the specified length of time. Refer to Section 504.04.E(5) of the Standard Specifications. Ensure that the polyethylene membrane remains secure, that there is adequate water supply, and that the soaker hoses are functioning properly.

Monitor thermometers on the deck. If the temperature of the deck drops below 50 degrees F, direct the Contractor to take corrective actions.

Ensure that the Contractor protects the deck against premature loading of the concrete as required by Section 504.04.H of the Standard Specifications.

Ensure that the Contractor’s removal of forms is in compliance with Section 502.04.C of the Standard Specifications.

CHECKLIST – BRIDGE DECKS, APPROACHES, RAILS AND PARAPETS

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Discuss Contractor's Bridge Deck Plans.					
Discuss source of materials.					
Verify concrete plant certification.					
Discuss pre-pour conference approval before deck placement can start.					
Determine who will survey beam elevations.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Pre-Pour Checks:					
Forms are mortar tight, cleaned, and oiled.					
Stay-in-place steel forms are lapped in the direction so the top form will be loaded first when concrete is placed.					
Concrete panels are set to allow concrete to flow between the bottom of the panel and the top of the beam.					
Falsework has been inspected and certified, and tell-tales installed and marked.					
Tell-tales have been placed on the overhang under the edge of the deck and in the middle of the deck to monitor differential dead load deflections.					
The cantilever is properly braced.					
Reinforcement is clean, coating damage is repaired, ties are tight, support provides a stable mat, and clearances and spacing meet plan dimensions and tolerances.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Finishing machine rails are stable.					
Back-up equipment is onsite in accordance with the Contractor’s plan.					
No oil or fuel leaks from machinery.					
Expansion joints are supported on the plates in the beams as shown in the plan details and they are set to the proper grades.					
The dry run produces cover, clearance, and deck thicknesses.					
Equipment and materials for weather protection are in place in accordance with the Contractor’s plan.					
Thermometers are placed near formed surfaces in cold weather.					
Work bridges, curing materials, and equipment are prepared for concrete placement.					
Fogging equipment is mounted on finishing machine and is capable of fogging the entire deck width behind the finishing operation.					
All nozzles work and the Contractor has a plan to replace nozzles that fail during the deck placement.					
Contractor acknowledges that fogging or blessing of the deck is not to be used to aid in finishing operations in any form.					
There is a water source capable of handling curing quantities.					
Curing compound application equipment provides application rate measurements.					
The shelf lives of curing compounds have not expired.					
Locations for concrete discharge, sampling, and testing have been identified.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
The proper mix design to be used and the quantity to be delivered compared to the estimated quantity needed have been discussed with the Contractor.					
The delivery time is acceptable.					
What retempering will be allowed, if any, has been discussed with the Contractor.					
If the concrete is pumped, the measures needed to obtain samples from the outlet end of the pump, not at the truck, have been discussed with the Contractor.					
If the concrete is going to be pumped, the possible configuration of the pump hose so as to minimize vertical drop and air loss has been discussed with the Contractor.					
Checks During Deck Placement:					
Before placement starts, check the forms and reinforcing steel one last time to ensure that no deleterious material has gotten on them.					
Confirm that the temperature of any surfaces that will be in contact with the concrete are greater than 35 degrees F and less than 100 degrees F.					
If water is used to cool the forms ensure that there is no ponding.					
Check the concrete tickets, especially on the first truck, to ensure that the proportions meet the proper mix design, that the concrete being delivered is Class AA, and that time limits from batching to placement and finishing are not exceeded.					
If the concrete is pumped ensure that the material to be tested is taken from the outlet end of the pump, not at the truck.					
Test concrete and discuss with the Contractor any adjustments that may be needed.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Note any water that is added to the concrete truck on the ticket for calculation of the water cement ratio.					
Concrete pumps usually run some grout through them before the concrete; ensure that the grout is not used in the deck.					
Ensure that concrete is not dropped more than 6 feet. Vertical drop of the concrete, even in the pump truck hose, will have a detrimental effect on the air content of the concrete.					
Ensure that the concrete is placed at a rate of at least 25 ft/hr measured longitudinally along the bridge deck.					
Do not allow workers to clean rakes or other equipment by beating them on epoxy coated rebar.					
Ensure vibrators are inserted vertically.					
Check tell-tales to ensure that deflections are according to plan and that the overhang is not deflecting more than the rest of the bridge.					
Ensure that the finishing machine provides a smooth surface that requires little or no additional work.					
Ensure that NO WATER is ADDED TO THE SURFACE TO AID IN FINISHING!!!!!! If it is, stop it immediately.					
Ensure that the fogging nozzles atomize the water droplets without creating pools of water on the finished surface and fog the entire deck width, immediately after concrete strike off.					
Check and document the thickness and cover of the finished deck at the edge and in the center.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Monitor and document the time it takes from the finishing machine strikes off to the placement of the first layer of wet burlap for curing and ensure that it does not exceed 10 minutes. The second layer must be placed within 5 minutes of the first layer.					
Ensure that placement of the wet burlap and the misting hoses are completed without damaging the concrete surface.					
Ensure that white polyethylene film is placed over soaker hoses and burlap.					
During cold weather placement, ensure temperature measuring devices are placed in accordance with the Contractor's pre-deck pour plan to confirm that the concrete surface temperature does not drop below 50 degrees Fahrenheit.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Ensure that the Contractor continuously water cures the concrete for at least 7 to 10 calendar days.					
Ensure that the white polyethylene is secure and that burlap stays continually wet during the curing period.					
Ensure that there is enough water to maintain curing during the curing period.					
Check and document the surface temperature of the deck to ensure that the temperature does not drop below 50 degrees F.					
Ensure that curing compound is applied within 30 minutes of removing wet burlap.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Verify that application of curing compound is at least 1 gallon per 200 square feet and looks like a white piece of paper.					
If the expansion joint assembly has rigid connections between their opposite halves, be sure that these connections are cut after the initial concrete set to prevent damage from joint movement due to thermal changes in the superstructure.					

SECTION 505 – OVERLAY OF CONCRETE BRIDGE DECKS

505.01 GENERAL

This work consists of preparing deck surfaces and placing a concrete, multilayer polymer concrete, or asphalt membrane overlay on a bridge deck and the approach pavement to provide a smooth transition to the main line pavement.

505.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Contractor must submit a work plan to the Resident Engineer at least 14 days before beginning surface preparation for the overlay.
- The type of overlay and method of surface preparation required by the Project Plans.
- Contractor's mix design and source of materials.
- Contractor's proposed schedule for work and any restrictions detailed in the Plans and Contract.
- No overlay concrete is to be placed until a pre-placement check is held and approved by the Resident Engineer in accordance with Section 505.04.E(1) of the Standard Specifications.

B. Acceptance of Materials

1. Mix Designs

(a) HC Concrete

The Contractor will submit its proposed concrete mix designs to the Resident Engineer for approval in accordance with Section 701.01.C of the Standard Specifications. As soon as practical, the Residency will obtain sufficient samples of the aggregates to be used and perform applicable tests on these materials.

(b) Hot Mix Asphalt (HMA)

The Contractor will submit its proposed HMA mix designs to the Materials Division for approval. The Resident Engineer will ensure that the HMA mix designs have been approved prior to the Contractor's placement of materials.

2. HMA and Concrete Plants

The Resident Engineer will verify that the proposed plant has been inspected and certified in accordance with Section 411.03.A of the Standard Specifications for

HMA or in accordance with Section 414.03.A of the Standard Specifications for concrete.

For High Density Concrete (HDC), the Contractor must provide proportioning and mixing equipment in accordance with Section 505.03.H or Section 414.03 of the Standard Specifications. The Contractor may use a mobile mixer with continuous mixing or a stationary concrete mixer with rotating-paddles.

For Latex Modified Concrete (LMC) and Early Strength Concrete (ESC), the Contractor must provide proportioning and mixing equipment of a self-contained, mobile, continuous-mixing type (volumetric based units) in accordance with Section 505.03.H of the Standard Specifications.

3. Sources of Materials

The Contractor will submit its proposed sources of materials. The Residency will verify that the proposed sources of materials are on the Approved Products List (APL). If a proposed source is not on the APL, the Resident Engineer must contact the Materials Division immediately. Verify the APL for the following:

- Structural Concrete, LMC, ESC and HDC – source for each individual component, in accordance with Section 509 of this Manual.
- Multiple Layer Polymer Concrete Overlay – source for the polymer will be from the APL [add link] and the aggregate requirements will be project specific.
- Waterproof Membrane for Asphalt Overlay – source for the waterproof membrane will be from the APL
- Reinforcing Steel – source for the reinforcing steel will be from the APL
- Curing Materials – source for the curing materials will be from the APL

C. Preparatory Work and Contractor Work Plans

1. General

Before work begins, the Contractor must submit a work plan for review by the Resident Engineer at least 14 days prior to beginning surface preparation. This plan must be in accordance with Section 505.04.B of the Standard Specifications. The Resident Engineer may consult Bridge Division and/or Materials Division for recommendations. This is an opportunity for the Department to ensure that the proposed materials, equipment and methods of construction satisfy the requirements of the specifications in a timely manner before work proceeds.

The following are some things to look for in the Contractor's plan:

- It should outline the process of deck removal and surface preparation.
- It must identify hydro-demolition for the surface preparation. Asphalt layers and a minimal amount of concrete may be removed by scarification.

However, hydro-demolition must be used to prepare the deck surface for overlay. All other methods tend to result in delaminated overlays.

- Vacuum equipment must be used to clean the deck shortly after the hydro-demolition.
- There must be a plan to treat runoff from the deck and to keep debris from getting on traffic. Typically, the water must be run through a sediment basin before it leaves the Project site. Hydro-demolition tends to throw debris around. If traffic is adjacent to the hydro-demolition, it will need to be protected. If traffic is under the hydro-demolition it may blow holes through the deck. The plan should describe a method to protect the traffic under the deck. Forming plans for areas like this should also be provided.
- Equipment to mix, consolidate, finish, and cure the overlay must all be listed as well as all back up equipment.
- It must list equipment and material quantities to protect the concrete from rain, and hot or cold weather.
- It must identify where the concrete will come from or if it will be mixed onsite. If it will be delivered, be sure that delivery times can be met. If it will be mixed onsite, the equipment must be identified, as well as the process of mixing and placing.
- Check the planned work schedule to ensure that it meets the Contract requirements for traffic control, cure time, phasing, etc. If it does not meet the Contract requirements, discuss the plan with the Contractor and Bridge Division to see if it is acceptable.
- The Contractor should provide some checks to ensure that the overlay will be the appropriate thickness and will achieve a smooth ride. These should include a survey of the deck and approach. The approach alignment will need to be transitioned over the deck to avoid a rough ride. A dry run should be performed to ensure no thin or thick spots will result. Thicker is not necessarily better, as this may result in cracking or delaminating. The Contractor should perform depth checks of the overlay during the placement as well.

2. Polymer Concrete Overlays

For polymer concrete overlays, ensure that the Contractor has included the following additional items in its work plan:

- The compatibility of patching materials with the polymer concrete overlay material,
- The minimum air and deck surface temperatures,
- The manufacturer’s approval of the work plan and the number of courses and minimum cure times for each course,
- The manufacturer’s written support of any deviations from these specifications, and
- Necessary test reports, documentation, explanations, and justification to support the proposal.

3. Asphalt Membrane Overlays

For asphalt membrane overlays, ensure that the Contractor has included the following additional items in the work plan:

- Type of membrane and tack that will be used,
- Limitations of pavement/deck temperature and moisture content and how they will be measured,
- Length of time the membrane can be exposed before the asphalt overlay is placed,
- Maximum temperature for the asphalt concrete overlay material, and
- How the curb line and deck drains will be sealed.

Provide to the Contractor in writing any corrections to the work plan or authorization to proceed.

D. Safety and Environmental Issues

Discuss with the Contractor its plan to:

- Protect workers and traffic during construction,
- Collect, store and dispose of concrete slurry produced by the hydroblasting and saw cut grooving operations,
- Shield traffic from debris, and
- Provide traffic control during construction.

505.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

1. Mix Designs

(a) HC Concrete

Ensure that the Resident Engineer has approved the concrete mix design in accordance with Section 701.01.C of the Standard Specifications. As soon as practical, the Residency will obtain sufficient samples of the aggregates to be used and will perform applicable tests on these materials. Any changes to the approved concrete mix design, including substitution of material sources, must be approved by the Resident Engineer.

(b) HMA

Ensure that the Materials Division has approved the HMA mix design. Any changes to the approved concrete mix design, including substitution of material sources, must be approved by the Materials Division.

2. HMA and Concrete Plants

Ensure that the proposed plant has been inspected and certified in accordance with Section 411.03.A of the Standard Specifications for HMA or in accordance with Section 414.03.A of the Standard Specifications for concrete.

For HDC, ensure that the Contractor has provided a mobile mixer or a stationary concrete mixer that has been certified in accordance with Section 505.03.H or Section 414.03 of the Standard Specifications.

For LMC and ESC, ensure that the Contractor has provided a self-contained, mobile, continuous-mixing type in accordance with Section 505.03.H of the Standard Specifications.

3. Sources of Materials

Ensure that the Contractor has submitted its proposed sources of materials. The Residency will verify that no changes were made from the proposed sources of materials and they are still on the APL. If a proposed source is not on the APL, the Resident Engineer must contact the Materials Division immediately.

Document or perform applicable tests as follows:

- Structural Concrete, LMC, ESC & HDC – Sample and test for each individual component, in accordance with Section 509 of this Manual.
- Multiple Layer Polymer Concrete Overlay – Ensure that the polymer is provided from an approved source, as shown in the APL [add link]. [Document in Template AM5001]. Sample and test the aggregates in accordance with the requirements in the Contract Documents.
- Waterproof Membrane for Asphalt Overlay – Ensure that it is provided from an approved source, as shown in the APL. [Document in Template AM5001].
- Reinforcing Steel – Accept in accordance with Section 511 of this Manual.
- Curing Materials – Ensure that they are provided from an approved source, as shown in the APL. [Document in Template AM5001]

B. Equipment and Methods

Refer to Section 505.03 of the Standard Specifications for the various types of, and the requirements for, the surface preparation, mixing, placing and finishing equipment.

Also, refer to Section 505.04 of the Standard Specifications for the specific types of equipment associated with the method of deck overlay required by the Contract.

Verify that the equipment on the job site conforms to the Contractor's work plan and is in compliance with the applicable specifications.

C. Construction Operations

1. Surface Preparation

Securing an adequate bond at the interface of the existing prepared deck surface and proposed overlay course is essential in obtaining a durable and maintenance free bridge overlay system. General surface preparation requires hydro-demolition, scarifying, shotblasting, and/or sandblasting depending on the surface condition or amount of existing surface material to be removed. When scarifying is used, ensure that the Contractor is careful not to snag the reinforcing steel. If the mechanical scarifying equipment snags the top mat of deck reinforcing steel, immediately stop operations and adjust the removal depth. Any reinforcing bar that is exposed must be sandblasted to remove all rust contaminants and unsound concrete. Also, prior to placement of the deck overlay material, the prepared surface must receive an air blast to remove dust and other foreign particles, followed by flushing with water.

(a) Asphalt Concrete and Polymer Concrete Overlays

Before allowing the Contractor to place asphalt concrete and polymer concrete overlays, ensure that the following activities have been performed:

1. Existing overlays, asphalt, unsound concrete, and foreign material are removed from the surface, and properly disposed of.
2. The deck surface has been cleaned by shot-blasting or water-blasting in accordance with Section 505.03.D of the Standard Specifications.
3. The surface has been shot-blasted after sand-blasting.
4. The deck has been tested for and shown to have no visible moisture by taping a plastic sheet to the deck for at least 2 hours in accordance with ASTM D4263.

Direct the Contractor to perform Class ‘A’, ‘B’ and ‘C’ bridge deck repair as required.

(b) Concrete Overlays

For all concrete overlays, scarifying is required to remove the existing asphalt or concrete overlay (when present) and to provide an initial scarification of the surface of the existing deck. Scarifying is to be followed by hydro-demolition, which includes the vacuuming of the concrete slurry and debris. Refer to Section 505.04.C(2)(c) of the Standard Specifications.

Verify the calibration of the hydrodemolition equipment through performance of a test strip.

The Contractor may use jack hammering in areas that are inaccessible to the scarifying and hydro-demolition operations.

"Sound" the deck (i.e. chain drag) to verify that all areas of unsound concrete have been removed. Ensure that the Contractor cleans and/or repairs any exposed reinforcing steel.

Direct the Contractor to perform Class 'C' bridge deck repair as needed. Class 'A' and Class 'B' bridge deck repairs will be placed monolithically with the overlay.

2. Pre-Placement Check for Concrete Overlays

Prior to the scheduled day for overlay placement, preferably the day before, conduct a pre-work conference onsite to review the plans and preparations for the pour. The Contractor's superintendent and key personnel, together with the Resident Engineer and available inspectors who will be involved, should attend. The Contractor must adequately address any deficiencies identified during the pre-placement check prior to placing the deck overlay material. At this time, the superintendent must state fully the Contractor's plan of operation and agreement must be reached between the superintendent and the Resident Engineer on the items described below.

(a) Asphalt Concrete and Polymer Concrete Overlays

Before allowing the Contractor to place overlay material, verify the following:

1. Delaminations have been removed by sounding the deck.
2. The concrete surface is clean and bondable.
3. The concrete patches have cured to specification requirements.
4. Equipment is operational.
5. Back-up equipment is onsite and does not leak oil or fuel.
6. The calibration of the mixing equipment produces the specified mix design and rate.
7. Equipment and materials specified in the Contractor's work plan for weather protection are in-place.

8. Air temperatures will be in compliance with Section 505.04.E of the Standard Specifications.

9. Type of membrane and tack that will be used.

10. Limitations of pavement/deck temperature and moisture content and how they will be measured.

11. Length of time the membrane can be exposed before the asphalt overlay is placed.

12. Maximum temperature for the asphalt concrete overlay material.

13. How the curb line and deck drains will be sealed.

(b) Concrete Overlays

Before allowing the Contractor to place overlay material, verify the following:

1. The forms are mortar tight, cleaned, and oiled.

2. Delaminations have been removed by sounding the deck.

3. The concrete surface is clean and bondable.

4. Reinforcing steel is clean.

5. Spliced-in new reinforcing steel replaces damaged reinforcing steel.

6. Reinforcing steel coating damage is repaired.

7. Ties are tight.

8. Support provides a stable reinforcing steel mat.

9. Clearances and spacing meet dimensions and tolerances as required by the Contract.

10. Finishing machine rails are stable.

11. Equipment is operational.

12. Back-up equipment is onsite and does not leak oil or fuel.

13. The dry run produces acceptable results for cover and clearance.

14. The calibration of the mixing equipment produces the specified mix design and rate.

15. Equipment and materials specified in the Contractor's work plan for weather protection are in-place.

16. Locations have been identified for temperature readings during cure period.

3. Inspection During Placement of Deck Overlay Material

The surface, once cleaned, must remain clean until the deck overlay material is placed. There have been cases where the prepared deck surface has become contaminated during the overlay operations by the concentrated traffic of vehicles transporting the concrete. This is especially true when the skid-steer type loaders are used to transport mix. The deck surface can become contaminated by the abrasive action between the concrete surface and the rubber tires, and also from oil and other foreign material tracked in from off the bridge. Contamination can be recognized by discoloration or oil on the deck surface. Contamination is especially noticeable in the wheel paths used by the vehicles.

To prevent the cleaned deck surface from being contaminated by traffic, the Contractor should cover any prepared surface with sheets of plywood, multiple layers of plastic, or other suitable material. To ensure a clean surface prior to placement of the overlay system, direct the Contractor to re-sandblast areas that become contaminated, followed by an air blast.

(a) Asphalt Concrete Overlay

The Inspector should verify the following:

1. A technical representative from the manufacturer is present to recommend the acceptability of all phases of the membrane operations to the Resident Engineer, including the surface preparations, placement of the membrane including flashing for the curbs, appropriate use of tack coats and primers, and type and method of application.

2. The Contractor places the waterproof membrane, primers and tack coats in accordance with the manufacturer's specifications, instructions, and provisions.

3. The type of membrane and tack being used matches specification requirements.

4. Membrane placement only occurs at temperatures of 50 degrees F or higher.

5. The membrane is placed to the extents indicated on the Plans, with sufficient overlap provided to ensure that water will not drain beneath the membrane.

6. The curb lines of the waterproofing membrane are sealed in accordance with the manufacturer's recommendations.

7. The waterproofing membrane is rolled with a pneumatic roller, unless otherwise directed by the manufacturer. Vibratory rollers are not to be used during pavement application.

8. The temperature of the asphalt concrete mix complies with the mix design. The temperature requirement for the mix must not exceed the requirements of the membrane.

9. The length of time the membrane can be exposed will not be exceeded before the Contractor places the asphalt overlay.

(b) Polymer Concrete Overlay

The Inspector should verify the following:

1. A technical representative from the manufacturer is present during polymer concrete overlay operations. The representative will recommend the acceptability of all phases to the Resident Engineer, including the surface preparation, component mixing, and type and method of application.

2. The Contractor sufficiently blends the polymer components, and uniformly covers the work area at the Contract required rate.

3. The Contractor applies layers of polymer overlay separately, in accordance with the manufacturer's recommendations, and at the minimum rate specified in Table 505:1 of the Standard Specifications.

4. Coverage rates are at least 7.5 gallons per 100 square feet.

5. Polymer and aggregate compounds are maintained at a temperature of at least 60 degrees F during application. Unless the manufacturer recommends otherwise in writing,

the polymer concrete overlay must be placed when the air temperature is between 55 and 85 degrees F, and is not expected to drop below 55 degrees F within 8 hours after application.

6. The finished overlay thickness measures at least ¼ inch from the highest point on the deck surface to the top surface of the polymer (not the peaks of the aggregate).

7. The curing rate times are in accordance with Table 505:2 of the Standard Specifications.

(c) Concrete Overlay – Class AA with Reinforcing Steel

The Inspector should perform the following inspection activities related to the Contractor's placement of concrete overlay:

1. Before placement starts, check the forms and reinforcing steel one last time to ensure that no deleterious material has gotten on them.

2. Verify that the concrete temperature for the overlay material ranges between 55 and 85 degrees F.

3. If the air temperature falls below 55 degrees F, ensure that the Contractor follows the cold weather practices identified in Section 505.04.E(3)(g) of the Standard Specifications.

4. Check the concrete tickets, especially on the first truck, to ensure that the proportions meet the proper mix design, and time limits from batching to placement and finishing are not exceeded.

5. If the concrete is pumped, ensure that the material to be tested is taken from the outlet end of the pump, not at the truck.

6. Test concrete and discuss with the Contractor any adjustments that may be needed (slump, air, temperature, etc.).

7. Note any water that is added to the concrete truck on the ticket for calculation of the water cement ratio.

8. Concrete pumps usually run some grout through them before the concrete; ensure that the grout is not used in the overlay.

9. Ensure that concrete is not dropped more than 6 feet. Vertical drop of the concrete, even in the pump truck hose, will have a detrimental effect on the air content of the concrete.

10. Ensure that the concrete is placed at a rate of at least 25 feet per hour measured longitudinally along the bridge deck.

11. Do not allow workers to clean rakes or other equipment by beating them on epoxy coated rebar. This will result in chipping of the epoxy coating.

12. Ensure that vibrators are not drug across rebar or used to move concrete. This action may damage the epoxy coating on the reinforcing steel and will cause segregation of the coarse aggregate. Vibrators should only be inserted vertically.

13. Observe if the finishing machine provides a smooth surface that requires little or no additional work. If excessive handwork is being required to provide a smooth surface, adjustments need to be made to the finish machine (alter angle of rollers, check pan for concrete build up, etc.).

14. NO WATER MAY BE ADDED TO THE SURFACE TO AID IN FINISHING!!!!!!

15. Ensure that fogging operations, for the entire overlay width, begin immediately after concrete strike off. The fogging nozzles must atomize the water droplets without creating pools of water on the finished surface.

16. Check and document the thickness and cover of the finished overlay at the edge and in the center. Check as soon as possible after the Contractor begins placing the overlay and then periodically throughout the pour, especially at the middle of the span(s).

17. Monitor and document the time it takes from when the finishing machine strikes off the concrete to the placement of the first layer of wet burlap for curing and ensure that it does not exceed 10 minutes. If the finish machine is run parallel to the skew of the bridge, the wet burlap may need to be placed parallel to the skew as well to meet the time requirements.

18. Monitor the time it takes to place the second layer of wet burlap. It must be placed within 5 minutes after the first layer.

19. Ensure that placement of the wet burlap and the misting hoses are completed without damaging the concrete surface.

20. Once the concrete has cured enough to allow foot traffic, check that soaker hoses are placed on the burlap to supply water to maintain saturation.

21. Ensure that white polyethylene film is placed over soaker hoses and burlap.

22. During cold weather placement, ensure temperature measuring devices are placed in accordance with the Contractor's pre-overlay pour plan to confirm that the concrete surface temperature does not drop below 50 degrees F for the time period required by Section 509.04.B of the Standard Specifications.

(d) Concrete Overlay – HDC, LMC, and ESC

The Inspector should perform the following inspection activities related to the Contractor's placement of concrete overlay:

1. Before placement starts, check the deck one last time to ensure that no contamination or deleterious material has gotten on it.

2. Verify that HDC overlays are at least 2 inches thick, and that LMC and ESC overlays are at least 1.5 inches thick, but no more than 3 inches thick. Direct the Contractor to limit the width of overlay passes to a maximum of 26 feet.

3. Verify that the concrete temperature for the overlay material ranges between 55 and 85 degrees F

4. If the air temperature falls below 55 degrees F, ensure that the Contractor follows the cold weather practices identified in Section 505.04.E(3)(g) of the Standard Specifications.

5. Require onsite mixing of the overlay material for high density, latex modified and early strength concrete.

6. Test concrete and discuss with the Contractor any adjustments that may be needed (slump, air, temperature, etc.).

7. Ensure that the concrete placement rate is in compliance with Table 505:3 of the Standard Specifications.

8. Observe if the finishing machine provides a smooth surface that requires little or no additional work. If excessive handwork is being required to provide a smooth surface, adjustments need to be made to the finish machine (alter angle of rollers, check pan for concrete build up, etc.).

9. NO WATER MAY BE ADDED TO THE SURFACE TO AID IN FINISHING!!!!!!

10. Ensure that fogging operations, for the entire overlay width, begin immediately after concrete strike off. Ensure that the fogging nozzles atomize the water droplets without creating pools of water on the finished surface.

11. Check and document the thickness and cover of the finished overlay at the edge and in the center. Check as soon as possible after commencing the overlay and then periodically throughout the pour, especially at the middle of the span(s).

12. NOTE: The curing requirements for ESC may vary due to time limitations and wet curing may not apply or may be reduced. Check your plans for specific requirements.

13. Monitor and document the time it takes from when the finishing machine strikes off the concrete to the placement of the first layer of wet burlap for curing and ensure that it does not exceed 10 minutes. If the finish machine is run parallel to the skew of the bridge, the wet burlap may need to be placed parallel to the skew as well to meet the time requirements.

14. Monitor the time it takes to place the second layer of wet burlap. It must be placed within 5 minutes after the first layer.

15. Ensure that placement of the wet burlap and the misting hoses are completed without damaging the concrete surface.

16. Once the concrete has cured enough to allow foot traffic, check that soaker hoses are placed on the burlap to supply water to maintain saturation.

17. Ensure that white polyethylene film is placed over soaker hoses and burlap.

18. During cold weather placement, ensure temperature measuring devices are placed in accordance with the Contractor's pre-overlay plan to confirm that the concrete surface temperature does not drop below 50 degrees F for the time period required by Section 509.04.B of the Standard Specifications.

4. After Placement of the Deck Overlay Material

(a) Asphalt Concrete and Polymer Concrete Overlays

After the deck overlay material has been placed, the Inspector should:

1. Ensure the overlay material is cured in a manner and for the time period required before allowing the Contractor to perform striping and/or opening the roadway to traffic.

2. Perform straightedge testing as required by specification.

3. Perform tensile strength testing on polymer overlays only, and as required by specification. When performing this test, avoid driving lanes, if possible; if this is not possible, be certain to avoid the wheel paths. If test results are outside acceptable limits, contact the Bridge Division.

(b) Concrete Overlays

After placement of concrete overlays, the Inspector should:

1. Verify that the concrete is continuously water cured for at least 7 calendar days. If more than 10 percent of the portland cement weight consists of pozzolans (fly ash, etc.), ensure that the curing period is at least 10 calendar days.

2. Ensure the white polyethylene is secure and that burlap stays continually wet during the curing period.

3. Ensure that there is enough water to maintain curing during the curing period.

4. Check and document the surface temperature of the overlay to ensure that the temperature does not drop below 50 degrees F.

5. Ensure that curing compound is applied within 30 minutes of removing wet burlap and at a rate of at least 1 gallon per 200 square feet. The curing compound must be applied uniformly and should look like a piece of white paper.

6. Direct the Contractor to maintain wet cure even while work is being performed on the overlay such as tying steel and setting forms for bridge rails.

7. Perform straightedge testing as required by specification before texturing.

8. Perform tensile strength testing as required by specification. When performing this test, avoid driving lanes, if possible; if this is not possible, be certain to avoid the wheel paths. If test results are outside acceptable limits, contact the Bridge Division.

5. Finishing and Curing (Concrete Overlays Only)

The Inspector should be aware of the general concrete finishing issues discussed below and in the following video.

Providing the proper cure for a bridge overlay has one of the highest impacts to longevity and performance of the overlay, and it is one of the hardest things to perform correctly. It is important to keep the water that is in the concrete from evaporating. Allowing water in the concrete to evaporate increases the rate of shrinkage and is the highest cause of overlay cracking. However, it is also critical to avoid adding water to the concrete, because this increases the water cement ratio and reduces the strength, which also leads to poor performance. A common practice that adds water to the concrete is for the concrete finisher to splash water on the overlay (blessing) or concentrate the fog from the curing operation in an area to aid in the finishing of the overlay. The finisher rubs the water into the surface of the concrete, which increases the water cement ratio substantially on the surface. This decreases the strength of the surface concrete and leads to a failure called scaling. This is where the surface concrete turns to powder, is removed by traffic, and exposes the aggregate. The best way to avoid adding water to the surface while minimizing evaporation is to fog the concrete surface from strike off until the wet burlap is placed. Any finish after the strike off should be kept to a minimum. The fog increases the humidity at the surface and reduces the air's ability to evaporate water from the concrete. As long as there is no buildup of water on the surface and no one rubs the water into the surface, the overlay should perform well.

In summary, the Contractor must fog all bridge overlay placements. Water from fogging must not be used as an aid to finish the concrete. Until application of the wet burlap, fogging must be continued to produce a semi-gloss water sheen on the entire surface. The concrete must be water cured in accordance with Section 504.04.E(5) of the Standard Specifications.

Based on the above, the Inspector should monitor the Contractor's operations and perform the following actions:

a. Ensure that concrete finishers are not blessing the overlay.

b. If finishers have to do very much work after the initial strike off, check the adjustment on the strike off machine to reduce or eliminate this work.

c. Make sure the fogging equipment is fogging the entire exposed surface of the concrete until the burlap is placed. Do not allow the Contractor to concentrate the fogging anywhere.

d. Have the Contractor repair any clogged fogging nozzles or any nozzles or pipes that drip water on the surface.

e. Make sure the burlap is placed as quickly as possible.

f. Make sure the burlap is at least damp when it is placed. If it is dry it will suck water out of the concrete.

g. The burlap should be soaked the day before the overlay placement. Burlap has wax on it and will resist holding water. Soaking it removes the wax. Even if the burlap was soaked the day before, ensure that it is still saturated when applied, as addressed in the following video.

h. Monitor the cure during the cure period. Make sure the entire overlay stays wet for the entire cure period. If the plastic blows off and exposes the burlap it will dry out areas. Have the Contractor repair the plastic immediately. The following video shows the importance of fully securing all sections of curing blankets. Ensure that the soaker hoses run constantly and keep the entire overlay wet for the entire cure period. Make sure the Contractor has plenty of water, the hoses are on constantly, and the entire overlay is being soaked.

i. When it is necessary to work on concrete during the curing period, such as placing overlay concrete adjacent to a construction joint, ensure that only that area immediately adjacent to the joint is exposed and the remaining area is protected from damage by the workers. Plywood sheets may be used for protection. The exposed area must be kept moistened until adjacent work is completed; after that the cover must be restored and normal cure resumed.

j. Ensure that floor forms used to cure the underside of the slab are not removed before the end of the curing period.

k. Inspect white polyethylene prior to use to ensure that it is sound and will retain the moisture required to cure the concrete. All holes and tears must be repaired so that they are watertight. The material should be rejected if defects are numerous and repairs are questionable, or if the plastic has cracked from aging. The white polyethylene film should be placed over the soaker hoses covering the concrete surface. The Contractor should use the widest available sheets and overlap adjacent sheets at least 6 inches. A pressure sensitive tape, mastic, glue, or other adhesive approved by the Resident Engineer must be used to tightly seal and form a waterproof cover. Ensure that the polyethylene film is secure enough to prevent displacement by the wind. Direct the Contractor to repair or replace sheet portions that become damaged before the end of the curing period, or lose waterproofing ability.

l. Ensure that the curing compound is applied within 30 minutes after completion of the water cure and removal of the wet burlap. The curing compound must be applied uniformly and should look like a piece of white paper.

m. The membrane should be applied in one or more separate coats by spraying as a fine mist, at a uniform application rate of one gallon per 200 square feet of surface. The rate of application is controlled by laying out in advance, on the surface to be cured, an area that will be properly covered by the number of gallons of compound in the spray container. The procedure helps ensure that the membrane is applied at not less than the required rate.

n. The curing membrane must be protected for at least 7 days. Direct the Contractor to apply an additional coat to marred areas of the membrane. If the curing membrane is continuously marred, the Resident Engineer may direct the application of wet burlap, polyethylene sheeting, or other impermeable material to ensure Contract requirements are met.

6. Texturing

The Contractor should begin grinding repairs and saw-cut grooving after the completion of the concrete curing period (7 to 10 days water cure and 7 days membrane cure). If spalling occurs, direct the Contractor to discontinue grooving and correct the cause. The grooves must be spaced in accordance with Table 504:1 of the Standard Specifications. Grooves must be no closer than 6 inches to devices such as scuppers, expansion and construction joints, and bridge rail. On skewed bridges, in order to accommodate the equipment used to saw the grooves, the grooves must be sawed from 2 inches to 2 feet from the expansion joint. This results in grooves with a staggered or stepped appearance.

Opening a structure to traffic prior to sawing grooves exposes the traveling public to a hazardous situation. Therefore, traffic must not be allowed on bridge overlays until after the grooves have been sawed.

If the Plans allow another texture in lieu of saw-cut grooving, the overlay surface must be textured to provide a surface satisfactory to the Resident Engineer. The texturing should take place as the pour progresses after other finishing operations have been completed. Note that if the concrete tears, or "mud balls" are produced on the surface, the Contractor needs to apply less pressure or wait a few minutes until the concrete begins to set. If an alternate method of texturing is used, it could impact the time period before placement of the burlap.

D. Safety and Environmental Considerations

Ensure that the Contractor does not dispose of concrete or slurry from sawing and texturing in waterways.

Ensure that the Contractor complies with its plan to protect workers and traffic during construction. This includes:

- Providing fall protection for workers,
- Preventing tools, material etc. from falling on traffic beneath, and
- Providing traffic control during construction.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- When surface preparation begins and the method used
- When the expansion joints are set, the ambient temperature, and the measured opening of the joint
- When the pre-overlay inspection occurred, who was in attendance, and any corrective actions identified
- When the overlay is placed
- Whether or not proper curing method is being performed and any deficiencies observed and corrective actions taken
- When the texturing is performed

2. Measurement and Payment

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

The Engineer will not measure Class A and Class B repairs necessitated by hydrodemolition for payment.

The Engineer will measure Saw-Cut Grooving in accordance with Subsection 506.05 of the standard specifications.

Documentation of these Square Yard items will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template.

a. Select the appropriate pay item from the list of contract pay items.

b. Open the ‘DWR Templates’ icon in the toolbar.

c. Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to be used as the method of documentation for the work performed.

d. Select the appropriate method of measurement from the Type radio button options. Depending on the option selected, enter the following information:

    1. Two Dimensional Measured Quantity Option.

    This option can be used to allow the template to calculate areas for progressive payments or for documenting the final quantity. Typically this option will be used for areas involving simple calculations which will only require length and width.

        a. In the appropriate fields, enter both a descriptive location and the station to station extents.

        b. Input the measured length and width to calculate an area.

        c. For additional areas or additional locations, with different dimensions, select the ‘New Row’ button.

    2. Calculated Quantity Option.

    This option will allow the input of quantities calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), and can be used for progressive payments or for documenting the final quantity of areas. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

a. In the appropriate fields, enter both a descriptive location and the station to station extents.

b. In the Placed Quantity field, enter the calculated quantity (SY) of the item completed.

c. In the Book/Folder/Envelope # field provide the location of the documentation for the calculations.

d. For additional areas or additional locations, with different dimensions, select the 'New Row' button.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

505.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

1. Compressive Strength

For structural concrete, LMC, ESC & HDC, ensure that the concrete attains the specified compressive strength in the time frame required for each specific type of concrete placed.

Ensure that the 28-day concrete compressive strength requirements have been satisfied in accordance with Section 509 of this Manual or as amended by the QC/QA Special Provision, if applicable.

2. Tensile Strength

The Resident Engineer will choose test sites. The Contractor is to notify the Resident Engineer 24 hours before performing the tensile strength test. At least one tensile test site should be provided for each span or at least one test site for each 300 square yards of deck surface. Testing will be performed in accordance with ASTM C 1583. Ensure that the tensile test results indicate a strength of at least 250 psi with 100 percent of the failure in the existing concrete deck. Testing results must be submitted to the Resident Engineer.

3. Straightedge Test

Before saw-cut grooving, the overlay surface should be tested with a 10-foot long straightedge placed parallel and then transverse to the centerline. Direct the Contractor to grind high areas greater than ⅛ inch from the lower edge of the straightedge.

4. Quality Control / Quality Assurance

If the QC/QA special provision for bridge deck acceptance is included in the contract, measurement of cracking in the bridge deck and reinforcing steel cover will be required for possible payment adjustment. The results of the air content and compressive strength may also result in payment adjustments.

5. Pavement and Bridge Deck Smoothness

If the smoothness special provision for bridge deck and approach slab is included in the contract, measurement of the smoothness of these elements will be required for possible payment adjustment and/or grinding.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

Ensure that the Contractor complies with the curing requirements for the specified length of time. Ensure that the polyethylene membrane remains secure, that there is adequate water supply, and that the soaker hoses are functioning properly.

Monitor thermometers on the deck. If the temperature of the deck drops below 50 degrees F, direct the Contractor to take corrective actions.

Ensure that the Contractor protects the deck against premature loading of the concrete as required by the Standard Specifications.

CHECKLIST – ASPHALT CONCRETE OVERLAYS

Part 1: Preconstruction

Issue	Yes	No	N/A	Comments	Initials
Contractor has submitted an acceptable work plan.					
Contractor’s mix design has been approved.					
Contractor’s source of materials is acceptable.					
Equipment Contractor has onsite conforms to its approved work plan and the Standard Specifications.					
Back-up equipment is onsite and does not leak oil or fuel.					

Part 2: During Construction

Issue	Yes	No	N/A	Comments	Initials
Pre-Placement Check:					
Existing overlays, asphalt, unsound concrete, and foreign material are removed from the surface, and properly disposed of.					
The concrete surface is clean and bondable.					
The deck surface has been cleaned by shot-blasting or water-blasting in accordance with Section 505.03.D.					
The surface has been shot-blasted after sand-blasting.					
Equipment and materials specified in the Contractor’s work plan for weather protection are in-place.					
Air temperatures will be in compliance with Section 505.04.E.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Checks During Overlay Placement:					
A technical representative from the manufacturer is present to recommend the acceptability of all phases of the membrane operations.					
The Contractor places the waterproof membrane, primers and tack coats in accordance with the manufacturer's specifications, instructions, and provisions.					
The type of membrane and tack being used matches specification requirements.					
Membrane placement only occurs at temperatures of 50 degrees F or higher.					
The membrane is placed to the extents indicated on the Plans, with sufficient overlap provided to ensure that water will not drain beneath the membrane.					
The temperature of the asphalt concrete mix complies with the mix design.					
The length of time the membrane can be exposed will not be exceeded before the Contractor places the asphalt overlay.					
Checks after Placement of Overlay Material:					
Overlay material is cured in the manner and for the time period required.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Overlay is the appropriate thickness.					
Overlay satisfies smoothness requirements.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Contractor protects the deck against premature loading.					

CHECKLIST – POLYMER CONCRETE OVERLAYS

Part 1: Preconstruction

Issue	Yes	No	N/A	Comments	Initials
Contractor has submitted an acceptable work plan.					
Contractor’s mix design has been approved.					
Contractor’s source of materials is acceptable.					
Equipment Contractor has onsite conforms to its approved work plan and the Standard Specifications.					
Back-up equipment is onsite and does not leak oil or fuel.					

Part 2: During Construction

Issue	Yes	No	N/A	Comments	Initials
Pre-Placement Check:					
Existing overlays, asphalt, unsound concrete, and foreign material are removed from the surface, and properly disposed of.					
The concrete surface is clean and bondable.					
The deck surface has been cleaned by shot-blasting or water-blasting in accordance with Section 505.03.D.					
The surface has been shot-blasted after sand-blasting.					
Equipment and materials specified in the Contractor’s work plan for weather protection are in-place.					
Air temperatures will be in compliance with Section 505.04.E.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Checks During Overlay Placement:					
A technical representative from the manufacturer is present during polymer concrete overlay operations.					
Coverage rates are at least 7.5 gallons per 100 square feet.					
Polymer and aggregate compounds are maintained at a temperature of at least 60 degrees F during application.					
The curing rate times are in accordance with Table 505:2 of the Standard Specifications.					
The finished overlay thickness measures at least ¼ inch from the highest point on the deck surface to the top surface of the polymer (not the peaks of the aggregate).					
Checks after Placement of Overlay Material:					
Overlay material is cured in the manner and for the time period required.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Overlay is the appropriate thickness.					
Overlay satisfies smoothness requirements.					
Overlay meets tensile strength requirements.					
Contractor protects the deck against premature loading.					

CHECKLIST – CONCRETE OVERLAYS

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Contractor has submitted an acceptable work plan.					
Contractor's mix design has been approved.					
Contractor's source of materials is acceptable.					
Equipment Contractor has onsite conforms to its approved work plan and the Standard Specifications.					
Back-up equipment is onsite and does not leak oil or fuel.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Pre-Placement Check:					
Forms are mortar tight, cleaned, and oiled.					
Delaminations have been removed by sounding the deck.					
The concrete surface is clean and bondable.					
Reinforcing steel is clean.					
Spliced-in new reinforcing steel replaces damaged reinforcing steel.					
Reinforcing steel coating damage is repaired.					
Ties are tight.					
Support provides a stable reinforcing steel mat.					
Clearances and spacing meet dimensions and tolerances as required by the Contract.					
Finishing machine rails are stable.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
The dry run produces acceptable results for cover and clearance.					
Equipment and materials specified in the Contractor's work plan for weather protection are in-place.					
Checks During Overlay Placement:					
No deleterious material has gotten on forms or reinforcing steel.					
Concrete temperature for the overlay material ranges between 55 and 85 degrees F.					
If the air temperature falls below 55 degrees F, Contractor follows the cold weather practices in Section 505.04.E(3)(g).					
Proportions meet the approved mix design.					
High density, latex modified and early strength concrete are mixed onsite, as applicable.					
Time limits from batching to placement and finishing are not exceeded.					
Tested concrete meets requirements (slump, air, temperature).					
No grout is not used in the overlay.					
Concrete is placed at the specified rates.					
Workers do not clean rakes or other equipment by beating them on epoxy coated rebar.					
Vibrators are not drug across rebar or used to move concrete.					
Finishing machine provides a smooth surface.					
NO WATER IS ADDED TO THE SURFACE TO AID IN FINISHING.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Fogging operations, for the entire overlay width, begin immediately after concrete strike off.					
Time from when the finishing machine strikes off the concrete to the placement of the first layer of wet burlap for curing does not exceed 10 minutes.					
Second layer of wet burlap is placed within 5 minutes of the first layer.					
Wet burlap and the misting hoses are placed without damaging the concrete surface.					
Once the concrete has cured enough to allow foot traffic, check that soaker hoses are placed on the burlap to supply water to maintain saturation.					
White polyethylene film is placed over soaker hoses and burlap.					
Concrete surface temperature does not drop below 50 degrees F for the time period required by Section 509.04.B.					
Checks after Placement of Overlay Material:					
Concrete is continuously water cured for at least 7 calendar days. (If more than 10 percent of the portland cement weight consists of pozzolans, the curing period must be at least 10 calendar days.)					
White polyethylene is secure and that burlap stays continually wet during the curing period.					
There is enough water to maintain curing during the curing period.					
Surface temperature of the overlay does not drop below 50 degrees F.					
Curing compound is applied within 30 minutes of removing wet burlap and at a rate of at least 1 gallon per 200 square feet.					
Curing compound is applied uniformly.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Overlay is finished and textured in accordance with specified requirements.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Overlay is the appropriate thickness and width.					
Overlay meets compressive strength requirements.					
Overlay satisfies smoothness requirements.					
Overlay meets tensile strength requirements.					
Contractor protects the deck against premature loading.					

SECTION 506 – STRUCTURAL STEEL

506.01 GENERAL

This work consists of providing, fabricating, and erecting steel structures and structural steel portions.

506.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Contractor's responsibility to furnish the necessary access and safety equipment to facilitate the inspection of all erection operations.
- Contract requirements regarding the submission of shop drawings, location of fabrication, and fabricator certification (AISC).
- Use of ODOT certified welders to perform all field welding.
- Contractor's responsibility to provide the necessary reports and/or certification before starting fabrication.
- Contractor's requirement to provide a Buy America certification.
- Bracing and falsework requirements in accordance with Section 502 of the Standard Specifications.
- Contractor's erection plan, noting that beams are not to be erected over traffic.
- If painting is required, the Contractor will need to submit his proposed method of preparation and the paint system to be used in accordance with Section 512 of the Standard Specifications.
- If bolting is required, discuss Direct Tension Indicator (DTI) and the Rotational Capacity Test in accordance with Section 506.04.F(6)(d) of the Standard Specifications.
- If work is being performed on an existing structure and includes the removal of the deck, discuss the method of removal to ensure that the Contractor does not cut or otherwise damage the top flange of the beam. (If damage is observed, the Contractor must suspend operations immediately and provide a method for repairing any damage. Contact Bridge Division for recommendations.) Note that on continuous span bridges, the top flanges are wider and thicker over the piers.

B. Acceptance of Materials

Generally, structural steel will be inspected and stamped by the Materials Division or its representative at the fabricator's facility.

Acceptance at the fabricator's facility, denoted by an inspection stamp, does not prevent subsequent rejection. The Resident Engineer may reject materials not meeting Contract specifications or steel damaged during delivery or by improper handling. The Contractor will immediately replace or correct rejected materials and work.

The use of foreign steel is discouraged and must be approved in advance by the Resident Engineer in accordance with Section 106.01.B of the Standard Specifications.

C. Preparatory Work and Contractor Work Plans

1. Work Plans

The Contractor must submit for approval working drawings for structural steel in accordance with Section 105.02 of the Standard Specifications. The working drawings will be submitted directly to the Bridge Division. The working drawings may consist of the following:

(a) Shop Drawings

Shop drawings show the dimensions of the component parts of the structure and details of miscellaneous parts. Bridge Division must approve the locations of shop welded splices. No field welding is to be allowed unless indicated on the shop drawings.

(b) Erection Drawings

Erection drawings show member locations. For steel superstructures that require falsework support during erection in accordance with Section 502 of the Standard Specifications, the Contractor must submit drawings of the proposed erection method, including details of falsework bents, bridge member attachments, erection sequence, and lifting point locations.

(c) Camber Diagram

Camber diagrams show the camber locations required on the Plans, at each panel point of trusses or arch ribs, field splices, and fractions of span length at least at every tenth point of continuous beams and girders or rigid frames.

(d) Transportation Drawings

If required by the Contract, transportation drawings must be submitted. These drawings must show support points, tie-downs, temporary stiffening trusses or beams, and other details to support and brace the member. Members must be shipped and stored upright.

2. Welding Quality Control Plans

If any field welding must be performed on main load carrying members, the Contractor must submit a quality control plan to the Resident Engineer for the work in accordance with ANSI/AASHTO/AWS, Bridge Welding Code D1.5. The Resident Engineer will submit the plan to the Materials Division for approval, and may request assistance from them in the inspection of this work.

3. Check of Bearing Seats

A final check must be made of the elevation of bearing seats on the piers and abutments before erection of structural steel members is scheduled to begin. If bearing seats are found that need correction, it must be performed in the manner and to the tolerances described in the section entitled “Girder Bearing Surfaces” in Section 509.04.K of the Standard Specifications.

Verify that beveled bearing plates are correctly oriented prior to erection and that any temperature corrections indicated in the plans are addressed.

Verify distance between anchor bolts / bearing assemblies.

D. Safety and Environmental Issues

Discuss with the Contractor its plan to protect workers and traffic during construction. The plan must address how the Contractor intends to:

- Provide fall protection for workers,
- Prevent tools, materials, etc. from falling on traffic beneath,
- Provide traffic control during construction, and
- Take precautions when handling and working with existing structural steel given the possible presence of lead-based paint.

506.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

Structural steel members are inspected by the Materials Division or its representative during fabrication and are stamped with markings to indicate compliance with specifications prior to shipment. The Residency Project Inspector must complete the material test template for acceptance of this item. [Document in Template AM5002].

There are some structural steel items that are provided without any inspection markings. These include bolts, nuts, washers, etc. Ensure that all required certifications and tests reports have been received before making payment for these items. Usually the unmarked structural steel is delivered to the Project site prior to receipt of the certifications and test reports, in which case, the Inspector should verify that all items have been supplied by an ODOT approved fabricator.

Ensure that the Contractor provides a Skidmore-Wilhelm calibrator, or an approved bolt—tension measuring device, at job sites that require the installation and tightening of high-tension strength fasteners. Use the tension-measuring device for the rotational—capacity test and to confirm the requirements of Table 506:6 of the Standard Specifications, as well as the wrench calibration. Ensure the bolting crew understands the tightening method.

If tightening bolts with DTI's, tighten to slightly below the DTI-specified load and then use a manual wrench to tighten to the Contract required tension. Record the number of refusals of a 0.005 inch tapered feeler gauge in the spaces between the protrusions. Ensure the maximum number of refusals for coated DTIs does not exceed one less than the spaces on the DTI. The Resident Engineer will reject the DTI if the number of refusals exceeds the values in Table 506:9 of the Standard Specifications, or if spaces refuse the gauge.

Ensure that the paint system used by the Contractor to coat exposed steel items is on the ODOT APL in accordance with Section 512 of this Manual.

B. Equipment and Methods

Ensure that the Contractor has equipment available to perform the necessary erection of the structural steel members and in accordance with Section 506 of the Standard Specifications, including but not limited to the following:

- Crane(s) of sufficient capacity to erect the members
- Skidmore-Wilhelm calibrator
- Tapered feeler gauges
- Drift pins and other necessary wrenches

Ensure that the Contractor's proposed methods for preparation and painting of exposed steel items are in compliance with Section 512 of the Standard Specifications. Before cutting or welding painted steel, the Contractor must remove paint within 9 inches of the work. Steel must be repainted in accordance with Section 512 of the Standard Specifications.

C. Construction Operations

1. Delivery and Storage

When the steel arrives on the site and prior to erection, it should be inspected for damage and quality of fabrication as thoroughly as time and conditions permit. Structural steel members must have an ODOT approved inspection stamp. If fabricated steel arrives onsite without an inspection stamp, notify the Materials Division. When the Contract or Plan notes allow fabrication of the structural steel onsite or allow the installation of used structural steel sections, the inspection stamp may not be required.

(a) Damage

Inspect pieces at point of delivery and report any damage caused by shipment to the Resident Engineer. The nature and extent of any damage that may have occurred because of loading, transit, or unloading should be noted and reported to Bridge Division, along with the identifying piece mark. If corrective work is deemed necessary by Bridge Division, advise the Contractor immediately so that the responsible party can be notified and correction can be performed in the most advantageous location. Any damage observed to the shop applied coatings (paint) must be repaired immediately to prevent rusting of the steel. Acceptance does not prevent subsequent rejection. The Department may reject materials or work not meeting Contract specifications.

(b) Storage

Structural steel members stored onsite shall be supported off the ground on blocking where it will not be affected by drainage, and beams will also be stored in an upright position. Often, contractors will secure angle iron across the top flanges of adjacent beams to prevent them from tipping over. If angle iron or other metal is secured across the top of the beams, it is important to ensure that the Contractor has not secured the angles or other metal by welding it to the beam.

Fastener systems (bolts, nuts and washers) stored onsite should remain in their original, sealed container until immediately prior to use. Opened containers should be resealed if there is any delay in the installation of the remaining bolts.

2. Field Splice Assembly

The beams or girders to be spliced must have their ends brought together at the correct relative elevation with respect to support points, and held at the elevation (and in correct alignment) so that heavy drifting is not necessary to align the holes. No tack welding will be allowed unless authorized by the Bridge Division.

The fastener systems are coated with a water soluble lubricant at the factory (see Figure 506:1). Once assembly begins, it must be completed in a timely manner to prevent the degradation of the lubricant. Do not allow the use of fastener systems that exhibit signs of rusting. Ensure that the fastener systems are compatible with the type of structural steel being used (e.g., weathering steel fasteners must be used with weathering steel members).

Figure 506:1. Photo. Proper Lubrication of Bolt Assemblies

Sufficient pins must be installed to obtain accurate alignment of parts and sufficient bolts to secure the splice. Splices and field connections should be assembled with at least two cylindrical driftpins per part. There must be at least eight cylindrical driftpins per splice or connection: a minimum of four driftpins in the web, two driftpins in the top flange, and two driftpins in the bottom flange. The pins must be placed in the corner holes of the splice plates.

At least every other diaphragm must be erected at the time the beams are set in place (see Figure 506:2). Where field bolted diaphragms are required by the Contract, they should be set in place with bolts or driftpins placed in half of the connection holes. Where field welded diaphragms are required by the Contract, they should be set in place by a 0.75-inch make-up bolt or temporary clamp at each connection point until the welding is completed.

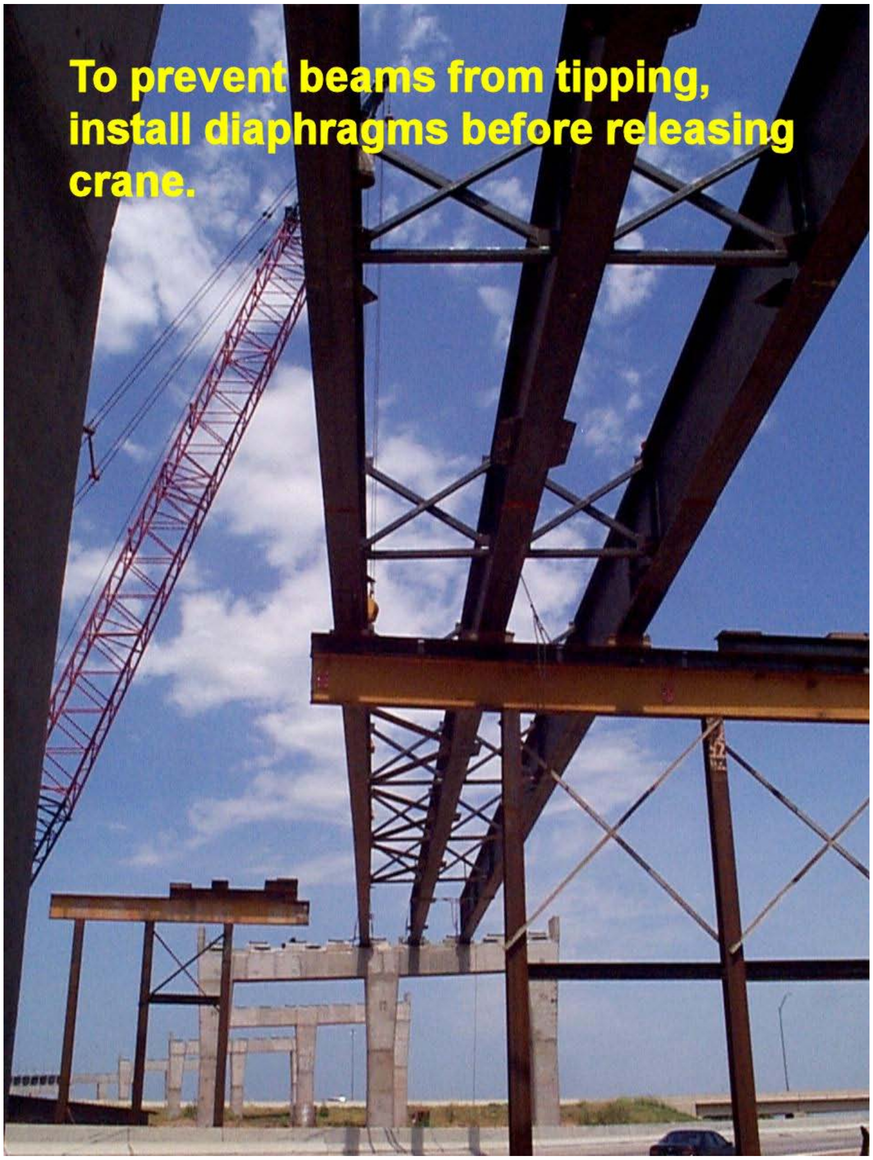


Figure 506:2. Photo. Diaphragm Installation

The Contractor should install additional cylindrical driftpins to align the parts. The remaining holes should be filled with bolts, tightened from the most rigid part of the connection to the free edges. The cylindrical driftpins will be replaced with tightened bolts.

Before the beams or girders are released and allowed to deflect, the Contractor must complete tightening of all bolts, then release temporary erection supports at a splice or connection. Ensure compliance with any special assembly and support situations indicated on the erection and falsework drawings.

Fitting-up bolts may be the same high-strength bolts used in the installation. If other fitting-up bolts are required by the Contract, the same nominal diameter as the high-strength bolts must be used. A tapered, cylindrical drift pin of sufficient size must be used to properly align the splice without causing damage to the bolt holes.

Due to the possibility of damaging the threads on the bolts, any bolts installed prior to installing the drift pins must be replaced.

On some beams and girders it is possible for the initial bolts used to secure the splice to become loose when the remaining bolts are installed. After all the remaining holes have been filled with bolts and tightened to at least a snug tight condition, ensure that the initial bolts are still snug tight.

When the splice is made on the ground, all operations to complete the splice shall be performed.

(a) Bolt Tightening

(1) Turn-of-the-Nut-Method

This method entails the following steps:

- Snug-tightening all of the bolts within the connection;
- Match marking the protruding end of all of the bolts and the adjacent surface of the nut; and
- Final-tightening of all of the nuts the additional specified rotation.

Greater variation in tension is usually obtained when the snug-tight condition is performed with power wrenches. More consistent tension is obtained with spud wrenches. Snug tight is accomplished by either an impact wrench or an ordinary spud wrench. If an impact wrench is used, snug tight is achieved when the impact wrench begins to impact or hammer on the bolt. This will happen almost immediately after tightening with the impact wrench begins. When a spud wrench is used, snug-tight is achieved when the full effort of a worker is applied to the spud wrench and the nut cannot be tightened any further.

Bolts must be match marked after the bolts have been tightened to a snug-tight condition. The Inspector must ensure that the match marks are placed on all the bolts prior to final tightening. The purpose of the match mark is to measure the amount of rotation of the nut relative to the bolt. The match marks must be placed properly in order to measure this rotation. The match marks must be placed on the end of the bolt and the adjacent surface of the nut. Contractors have placed match marks in several other locations; however, none of these locations allow the relative rotation of the nut to the bolt to be measured

During final tightening, all of the specified rotation must be performed. Although the bolts may be over-tightened in the snug-tight condition by power wrenches, the full specified rotation is still required. A maximum tension is not specified and excessive tension is not cause for rejection. Ensure that all bolts have been turned the required amount by observing the match mark locations. If the Contractor removes a bolt after completion of the final tightening, that bolt will be disposed of and may not be used again.

(2) Installation of Alternative Design Bolts

If alternative design fasteners are used, ensure that they are installed in accordance with the manufacturer's recommendations and as approved by Bridge Division.

(3) Direct Tension Indicator (DTI) Method

If the Contract requires use of DTIs (conforming to Section 724.02 of the Standard Specifications) with high-strength bolts to indicate bolt tension, verify that the Contractor complies with the testing and installation requirements in Section 506.04.F(6)(d)6) of the Standard Specifications.

DTIs must be installed with the protrusions against the head of the bolt and the nut turned to tighten the fastener. The element against the DTI must be prevented from turning during installation and final tensioning.

There are two stages to installing fasteners using DTIs:

- First, the Contractor will snug the connection with bolts installed in the connection holes, and then will tighten them to bring the plies of the connection into firm contact. If the number of spaces in which a 0.005 inch feeler gauge is refused exceeds those listed under "Maximum Verification Refusals" in Table 506:9, "Direct Tension Indicator Requirements", the assembly must be replaced, and re-snug.
- The connection is then tightened until the number of refusals of the 0.005-inch feeler gauge is equal to or greater than the number listed under "Minimum Installation Refusals" in Table 506:9. To minimize relaxation of previously tightened fasteners, fasteners should be retightened from the most rigid part of the connection to the free edges. If no gap remains, the fastener is over tensioned and must be replaced.

Perform verification testing in accordance with Section 506.03.A of this Manual. If any changes are made to the fastener system being used or if conditions in the existing system change, they must be re-verified.

3. Welding

No attachments, other than those specified in the Plans, may be made by welding to any main structural members such as beams, girders, cross bracing, truss members, etc., unless accepted by the Bridge Division. The Contractor may not weld stay-in-place forms or their support straps to the beams.

Any field welding must be performed in accordance with ANSI/AASHTO/AWS, Bridge Welding Code D1.5. The Resident Engineer may request assistance from the Materials Division in the inspection of this work.

(a) Approval of Welders

All field welders must be approved by the Materials Division prior to any welding. Verify approval of all welders by reviewing the welders' Welder Operator Certification Card and determining if they have satisfactorily welded on a Department project within the last twelve months. A list of qualified welders is maintained by the Materials Division and is available in SiteManager.

Once the work has been satisfactorily completed, sign and date the welders' Welder Operator Certification Card.

(b) Electrodes and Welding Procedures

The use of shielded metal arc electrodes (stick welding) is the only pre-approved welding procedure. Electrodes used to make all permanent welds to steel must be of the low hydrogen type (E7018) unless otherwise approved by Bridge Division.

In order to prevent moisture in the atmosphere from being absorbed by the electrodes (which can cause potential cracking of the weld), all stick electrodes must be purchased in a hermetically-sealed container or must be dried in an oven at 450 to 500 degrees F for two hours and stored in a suitable container that will maintain a temperature of not less than 250 degrees F. After removal for use, stick electrodes exposed to the atmosphere for more than four hours must be re-dried at a temperature of 450 to 500 degrees F before use.

When electrodes have become wet, the coating on the electrode is altered. Drying the electrodes does not restore the electrode coating to the original manufactured condition. Therefore, electrodes that become wet shall not be used.

(c) Weather Restrictions

Do not allow the Contractor to weld during rainy or foggy conditions. Welding in wet conditions will cause hydrogen embrittlement and result in fatigue cracking of the weld.

Do not allow the Contractor to weld when the base metal temperature is below 50 degrees F, unless they preheat and post-heat the metal to the temperature specified in the ANSI/AASHTO/AWS, Bridge Welding Code D1.5. Allowing the weld to cool too rapidly to the ambient temperature will cause cracking of the weld.

(d) Welding Inspection

Observe the welding operations and inspect complete welds for conformance to the Plans and shop drawings. Fillet welds must be measured with the use of a weld gage or other method that will show the length of the sides in contact with the steel. Deficient welds must be built up to the required size. Badly-shaped welds or welds containing defects such as cracks, pits, craters, and undercutting must be corrected to the satisfaction of the Resident Engineer.

Figure 506:3 and Figure 506:4 show pitted welds requiring repair work.

The Resident Engineer may request assistance from the Materials Division in the inspection of this work.

Figure 506:3. Photo. Pitted Welds in need of Repair

Figure 506:4. Photo. Pitted Welds in need of Repair

Complete joint penetration welds are when penetration by the weld metal extends throughout the full thickness of the base metal in a joint with a groove weld (two pieces of structural steel butt welded together, such as when a section of beam is removed and replaced due to an overheight beam strike). (see Figure 506:5) Ultrasonic Testing (UT) is required on all complete joint penetration welds prior to acceptance. The Resident Engineer must contact the Materials Division for UT testing.

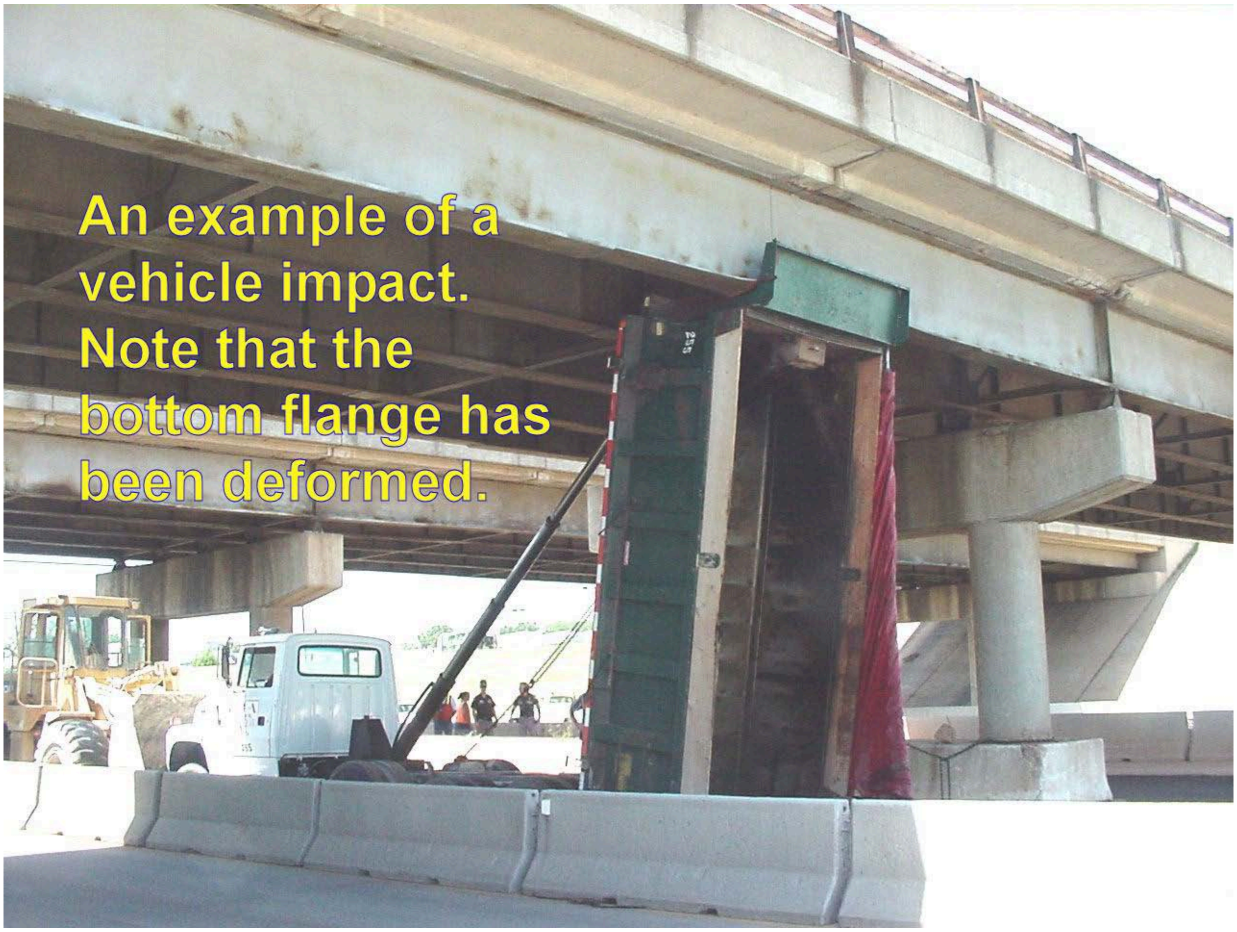


Figure 506:5. Photo. Deformation Caused by Vehicle Impact

(e) Arc Strikes

Occasionally during the welding operation, the electrode will come in contact with an area of steel that is not to be welded. This contact will result in a small burnt spot (or arc strike) in the steel. If not properly removed, an arc strike has the potential of propagating fatigue cracks. Arc strikes are detrimental to the integrity of the structural steel; therefore, if arc strikes are observed, suspend the welding operations immediately, until welding can be performed without arc strikes.

All arc strikes must be removed by grinding in accordance with Section 3.10 of the Bridge Welding Code D1.5 (add link to D1.5). These arc strikes can result in unacceptable hard spots or small cracks. Therefore, after the arc strikes are removed, the Contractor must check every location where they occur where the steel is in tension. The Contractor must perform a magnetic-particle test on all arc strikes in these locations to ensure that no cracks are present. Hardness tests must also be run on all locations to ensure that no unacceptable hard areas are present. Hardness values shall not exceed the higher of Rockwell C30 or the hardness value measured in the steel outside the location of the arc strike. If the above testing reveals unacceptable results, the flaw can be removed by grinding and the steel should be retested to ensure that the flaw has been completely removed.

Figure 506:6. Photo. Proper Removal of Arc Strikes by Grinding

Normally, the Contractor is not equipped nor has the knowledge to perform the above testing. Therefore, he will normally make arrangements for a private testing laboratory to perform the required testing. Contact Materials Division if any assistance is required.

(f) Cleaning Of Welds

The finished weld must have all slag removed and be neutralized by vigorous wire brushing to remove any film that will affect the proper adherence of paint. All welds that are to have ultrasonic testing performed shall be ground smooth to the base metal.

(g) Stud Welding

Shear studs are short rods that have been welded to a piece of steel for the purpose of anchoring that steel to concrete. Typically the shear studs are attached to the beams when they are fabricated, and no additional testing is required. However, when the studs are attached to the beam in the field, they must be attached in accordance with Section 7 of the Bridge Welding Code D1.5 (add link), as there are additional requirements for inspecting the weld joining the shear stud to a piece of steel.

When the first two studs welded on each beam or girder cool, they must be bent to 45 degrees by striking the studs with a hammer. If failure occurs in the weld of either stud, the welding procedure must be corrected. Do not allow the Contractor to resume welding operations until satisfactory test results are obtained for two successive studs. In addition to the first bent studs, one of every hundred studs must be bent to 45 degrees when the temperature of the base metal is below 32 degrees F.

Visually examine the studs after they have been welded. If they were welded properly there must be weld metal completely around the base of the stud (360 degree flash).

In addition to a visual examination, the studs must be bent to an angle of approximately 45 degrees from their original axis. The studs may be bent by either striking them with a hammer or bending the stud with a pipe.

If the visual examination does not reveal a 360-degree flash or if the weld fails when the studs are bent over, the Contractor must make corrections to his procedure and two more studs must be welded and tested. This must continue until two consecutive studs are tested and found to be satisfactory.

After the studs have been welded, it is necessary to test the studs to ensure that they have been installed correctly. Test the studs by giving each one a light blow with a hammer. When the studs are tapped, they should emit a ringing sound. Any stud that does not emit a ringing sound must be bent approximately 15 degrees from its original axis.

Perform a visual inspection in addition to tapping the studs with a hammer. Any stud that does not show a 360° flash may be repaired by the Contractor by fillet welding the missing flash. Any stud that the Contractor elects not to repair, or any stud that the Contractor has not repaired properly, must be bent to an angle of approximately 15° from its original axis.

Any stud that does not pass the bend test must be replaced. All studs that have been bent and have not failed must not be straightened.

4. Bearing Adjustment

When steel beams or girders are first landed, and before sole plates are fastened, bearings may be set approximately plumb. After all beams or girders between expansion joints are in place and the overall length has been checked, temperature corrections should be made in the plumbness of the bearings. The length of bridge from the fixed bearing and the deviation in temperature of the steel from 60 degrees F must be used in positioning the anchor bolts in the slots in accordance with the table shown in the Plans.

Adjustments should be made on a cloudy day or early in the morning when a temperature differential in the steel is not caused by the sun's rays.

D. Safety and Environmental Considerations

Ensure that the Contractor complies with its plan to protect workers and traffic during construction. This includes:

- Providing fall protection for workers,
- Preventing tools, material, etc. from falling on traffic beneath,
- Providing traffic control during construction, and
- Taking adequate precautions when handling and working with existing structural steel given the possible presence of lead based paints.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location of structural steel members erected, connected, repaired, etc. (i.e. span #, beam line)
- Any conditions requiring corrective actions, individual contacted, and their recommendations
- Who performs the corrective actions
- Verification and documentation of the welder's qualifications
- Where shear stud testing is performed
- Results of Skidmore-Wilhelm testing, turn of the nut method, and/or DTI testing for bolted connections

2. Measurement and Payment

The Resident Engineer may process payment for material on hand for structural steel elements when requested by the contractor in accordance with section 109.07 of the standard specifications. Documentation and payment for these items will usually be performed by the Residency Office personnel (Auditor, Lab Manager, etc.) and will be completed within the SiteManager / Contract Administration / Stockpiled Materials window.

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Work Items tab or in the change order (i.e. description, explanation, attachment, etc.).

Documentation of these items will be performed within the SiteManager / Daily Work Reports / Work Items tab.

- Select the appropriate pay item from the list of contract pay items.
- In the appropriate field, enter the descriptive location (i.e. Bridge 'A' – Span #1 – Beam #3) or the station to station extents and location.
- In the Placed Quantity field enter the pounds of structural steel complete in place. This quantity will either be as shown on the plans or as indicated by invoice/approved shop drawing, if the structural steel item is not specified as Pay Plan Quantity.

In the SiteManager / Daily Work Reports / Work Items tab / Remarks Bubble, provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown.

506.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

The Contractor must provide a Buy America certification in accordance with Section 106.01(b) of the Standard Specifications and provide documentation for any foreign steel incorporated into the project.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated (i.e. summary of invoices, spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantities paid equals the plan quantity.

C. Protection of the Work

Ensure that the Contractor completes diaphragm construction in a timely manner or takes appropriate action to brace the beams and prevent any movement. As shown in Figure 506:2, the crane should not be released until the diaphragm installation is complete to prevent movement.

Obtain survey of haunch grades for use in Section 504 of this Manual.

Ensure the Contractor does not perform any welding to the steel members other than that indicated in the plans (i.e. stay-in-place deck forms must not be welded to the beams)

Verify that the cantilever is properly braced. The Contractor must submit bracing detail to the Bridge Division for approval prior to placing the deck. The bowing seen in Figure 506:7 is the likely result of inadequate bracing during the deck pour. Similarly, the sagging in Figure 506:8 was also due to improper beam bracing.

If work was performed on an existing structure and included the removal of the deck, verify that the Contractor did not cut or otherwise damage the top flange of the beam. If damage is observed, direct the Contractor to provide a method for repairing the damage. Bridge Division must approve the Contractor's repair methods.

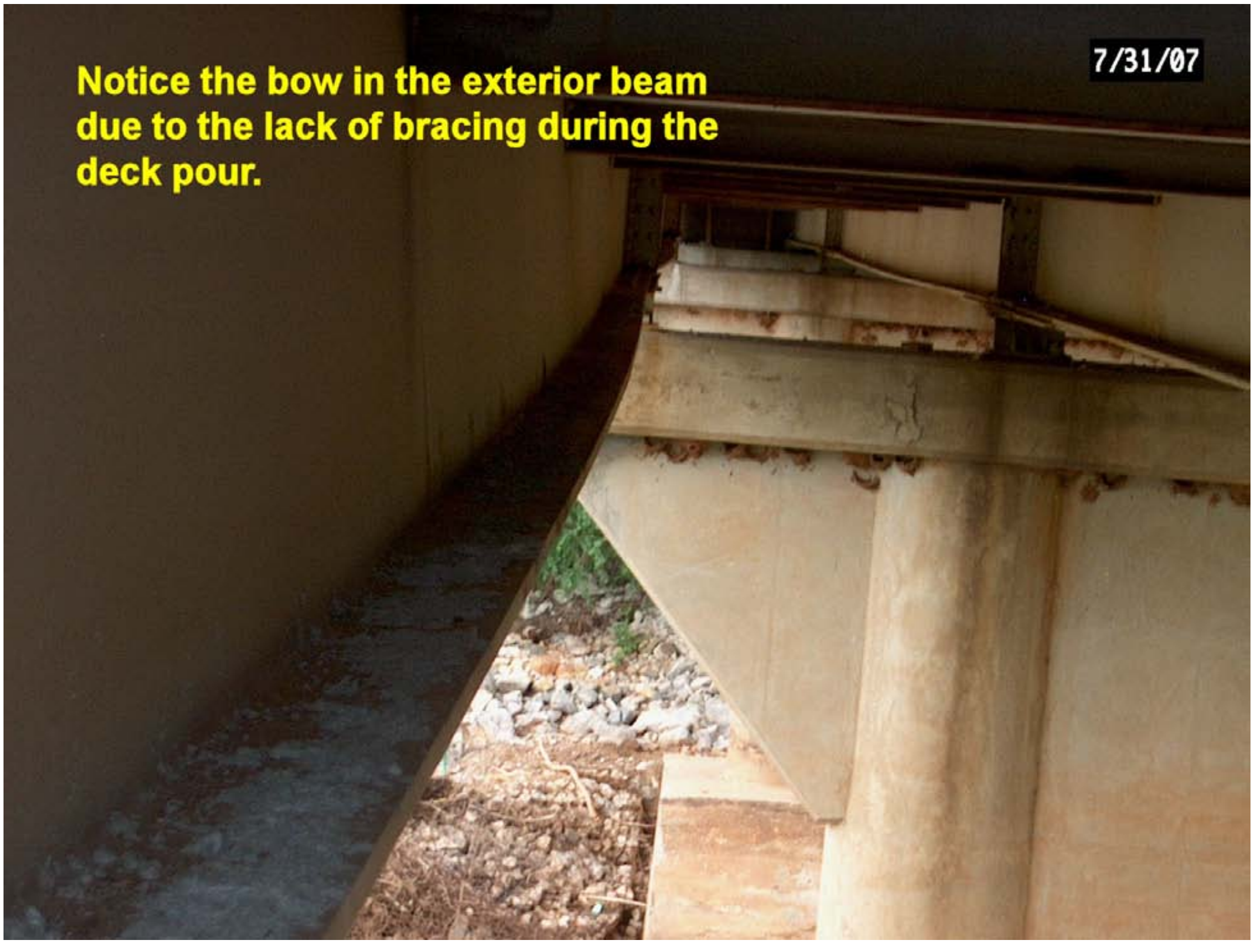


Figure 506:7. Photo. Bowing of Exterior Beam due to Inadequate Bracing

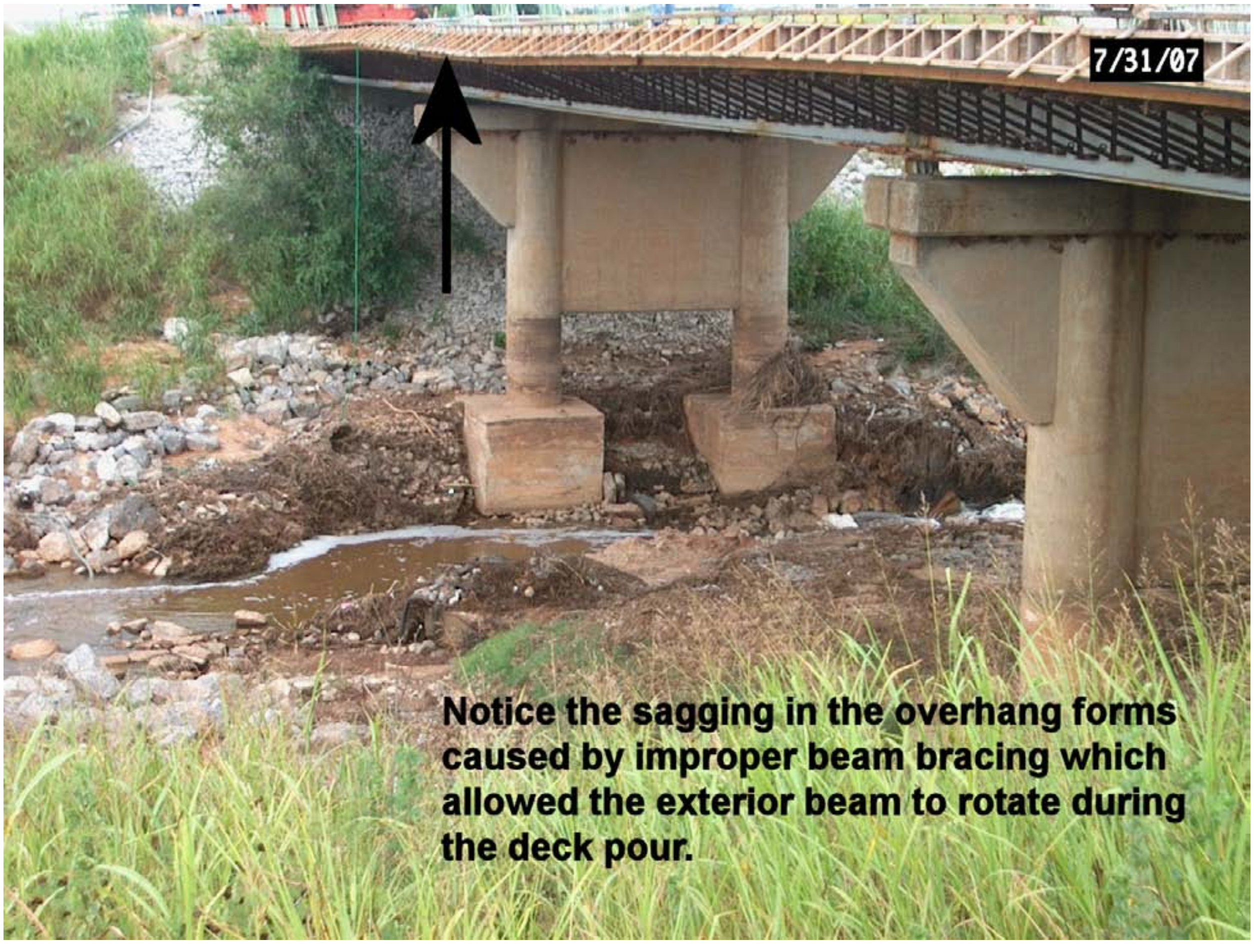


Figure 506:8. Photo. Sagging due to Inadequate Beam Bracing

CHECKLIST – STRUCTURAL STEEL

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Contractor has provided safety equipment and access for inspection.					
Fabricator has the required level of certification.					
Contractor has submitted shop drawings.					
Contractor will provide proper material certification and test reports before erection.					
Contractor will use ODOT certified welders for any field welding.					
Welding quality control plans for field welding have been approved by Materials Division.					
DTI bolt tensioning and Skidmore - Wilhelm calibration test that must be performed before erection have been discussed with the Contractor.					
Paint system for the Project and any preparation have been discussed with the Contractor.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Field Welding and Repairs:					
Welding quality control plan has been approved.					
Materials Division has been contacted for aid in inspection.					
Falsework has been design and installed in accordance with Section 502 of the Standard Specifications.					
Paint is removed before any cuts or welds are made.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Steel edges to be welded are ground properly.					
Only E7018 electrodes are used. • They come in sealed container. • Heated in ovens at 250 degrees F for 4 hours before use. • Used within 4 hours of heating.					
Slag from the last weld is removed before it is welded over.					
Welds are performed on dry low humidity days. The steel is pre-heated on cold days.					
The welds are smooth with no flaws such as bubbles or cracks.					
Arc strikes are ground out.					
Field welds are only made as shown in the Plans or approved by Bridge Division.					
Beam Erection:					
Check bearing set elevations and size and have Contractor correct any that are out of tolerance.					
Verify distances between anchor bolts and bearing assemblies on a beam line are within tolerance.					
Verify that the anchor bolts and bearing assemblies are not within 6 inches of the edges of the abutments or pier caps.					
Skidmore-Wilhelm calibration test has been performed on the bolt assemblies.					
Verify that shop drawings, erection drawing, camber drawings, and transportation drawings have been approved by Bridge Division.					
Verify that materials reports for charpy V-notch, strength, Buy America, etc. are available.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Inspect beams upon arrival for inspection stamps, and any damage.					
Check the Contractor's paint system for compliance with the Contract.					
Beams should be erected as they are delivered, but if they are stored, ensure they are stored upright, on blocks, and supported to prevent tipping.					
Verify that the plates to be spliced are clean and the holes match. They usually have an identification matching the splice to the beams.					
Verify that the fasteners are lubricated. Reject any that have any form of rust.					
Verify Contractor's DTI clearance measurements for snug tight and tightened conditions. **<u>This is one of the most critical items.</u>**					
Fasteners can only be tightened one time. Reject any fasteners that are reused.					
Ensure beams are braced until they are tied together with diaphragms.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Ensure that no field welds are made to beams. Common occurrences are: 1. Diaphragm bolt holes do not align so the Contractor field welds them to the diaphragm connection plate. 2. The welder starts before or ends after the support steel strap to channel connection for steel stay-in-place forms. That small arc strike or weld has to be ground out. 3. Overhang bracing is field welded to beams or studs. There are arc strikes around expansion joint welds or bearing plate welds.					
Ensure beams are clean after deck placement.					

SECTION 507 – BEARING ASSEMBLIES

507.01 GENERAL

This work consists of providing and installing bearing assemblies and elastomeric bearing pads.

507.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Contractor to provide source of bearing assemblies (anchor bolts and nuts, bearing plates and elastomeric bearing pads).
- Contractor to submit shop drawings to ODOT Bridge Division.
- Contractor to submit source for IZ-E-U paint system.
- Proper orientation and positioning of the bearing plates if they are beveled and/or slotted.

B. Acceptance of Materials

Generally structural steel plates used in bearing assemblies will be inspected and stamped by the Materials Division or its representative at the fabricator's facility.

Acceptance at the fabricator's facility, denoted by an inspection stamp, does not prevent subsequent rejection. The Resident Engineer may reject materials not meeting Contract specifications and steel damaged during delivery or by improper handling. The Contractor must immediately replace or correct rejected materials and work.

The anchor bolts, nuts and washers are provided without any inspection markings. Ensure that all required certifications and tests reports have been received before making payment for these items. Usually the unmarked structural steel is delivered to the Project site prior to receipt of the certifications and test reports, in which case the Inspector should verify that all items have been supplied by an ODOT approved fabricator [link to APL].

Field welding of beams to anchor plates is to be performed by a welder certified by the Materials Division. Verify that the welder is certified by checking his welding card prior to welding. A certified welder must have tested or have performed a satisfactory weld in the presence of an ODOT inspector within the last year as witnessed by signature and date on the card back.

The bearing pads will be inspected by Materials Division or its representative. This inspection may be performed in one of two ways:

- Bearing pads furnished with precast concrete or structural steel beams will be inspected by a Materials Division representative at the fabricator's facility. No identifying mark or stamp will be provided on the pad, and certification will be supplied to the Materials Division for distribution to the Residency.

- Bearing pads furnished by the Contractor or directly shipped to the Project site will be inspected by the Materials Division. A sample pad must be delivered by the Residency to the Material Division for non-destructive testing, after which the Materials Division will provide certification. The pad may be picked up by the Residency and returned to the Project site for use. In the event that the pads are deemed cumbersome by the Materials Division, an inspector from Materials Division will visit the Project site for testing.

C. Preparatory Work and Contractor Work Plans

Before work involving the installation of bearing devices begins, consider the following guidelines:

1. Contract Plans and Specifications

Review the Contract. Pay particular attention to the location and types of bearing devices required. Know the certification and installation requirements for each type of bearing to be installed.

2. Inspection Upon Delivery

Ensure that the bearings have been delivered to the correct location and are the proper type for the structure. Check that each bearing was properly packaged to prevent damage and contamination. Verify that the bearing plates have been stamped with acceptable ODOT inspection markings. Do not allow the installation of bearings that fail to meet these delivery requirements until Bridge Division has been contacted and the issues have been resolved.

D. Safety and Environmental Issues

Ensure that the Contractor is aware of employee safety requirements when welding the beam to the painted bearing plate.

507.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

Components of the bearing assemblies are inspected by Materials Division during fabrication and the bearing plates are stamped with markings to indicate compliance with specifications prior to shipment. Written certification will follow in approximately two weeks. The Residency Project Inspector must complete the AM5002 material test template for acceptance of these items. [Document in Template AM5002]

If required on the Project, verify that the paint system used by the Contractor to coat any exposed steel items is on the ODOT APL in accordance with Section 512 of this Manual.

B. Equipment and Methods

Ensure that the Contractor's proposed methods for preparation and painting of exposed steel items are in compliance with Section 512 of the Standard Specifications.

Welding must be performed in accordance with ANSI/AASHTO/AWS, Bridge Welding Code D1.5. The Resident Engineer may request assistance from Materials Division in the inspection of this work.

C. Construction Operations

1. Concrete Surface/Bearing Seat

Conduct a final check of the elevation of bearing seats on the piers and abutments before the scheduled start of placement of bearing assemblies. Verify that the concrete surface is clean and free of cracks. If bearing seats are found that need correction, it must be performed in the manner and to the tolerances described in the Section 509.04K of the Standard Specifications.

2. Installation/Adjustment

Check to ensure that bearing plates are positioned to the correct grade and superelevation and are in full contact with the bottom flange of the girder. Verify that beveled bearing plates are correctly oriented prior to erection and that any temperature corrections indicated in the plans are addressed. Verify distance between anchor bolts / bearing assemblies.

Two anchor nuts must be placed on each anchor bolt and tightened one against the other. There must be a 1/8-inch gap between the bottom of the bottom nut and the top of the washer on the anchor plate.

3. Protection of Bearings

Ensure field welding of bearing plates to bottom flanges or embedded sole plates are in accordance with Section 724.03 of the Standard Specifications, including that the welder is certified. Ensure that any paint and/or primer is removed from weld location prior to welding. The elastomeric or bonded bearing pads must not be exposed to temperatures greater than 400 degrees F. If bearing plates are less than 1.5 inches thick, the Contractor must provide temperature measurements of the steel adjacent to the elastomer to ensure that the steel does not exceed the temperature limitations. The elastomeric bearing pads must be replaced if the temperature exceeds 400 degrees F.

Once the welding has been satisfactorily completed, sign and date the welders' Welder Operator Certification Card and document in SiteManager Template C94043.

If the centerline of the bearing does not horizontally line up within 2 inch of the vertical bearing stiffener, weld additional bearing stiffeners to the steel beam or girder. Contact Bridge Division for location of additional stiffeners.

In welded areas, repair the primer and paint bearing assemblies with the IZ-E-U paint in accordance with Section 512 of the Standard Specifications.

D. Safety and Environmental Considerations

Bearing assembly components are heavy and cumbersome to handle. Care should be taken to avoid personal injury.

Ensure that the Contractor is aware of employee safety requirements when welding the beam to the painted bearing plate.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location of bearing assemblies installed (e.g. abutment or pier #, beam line)
- Any conditions requiring corrective actions, the individual contacted and their recommendations
- Who performs the corrective actions
- Verification and documentation of welder's qualifications

2. Measurement and Payment

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Work Items tab or in the change order (i.e. description, explanation, attachment, etc.).

Documentation of these items will be performed within the SiteManager / Daily Work Reports / Work Items tab.

- Select the appropriate pay item from the list of contract pay items.
- In the appropriate field, enter the descriptive location (i.e. Bridge 'A' – Abutment #1 – Beam #3) or the station and location.
- In the Placed Quantity field enter the number of bearing assemblies complete in place. This quantity will either be as shown on the plans or as actual counted in place, if the structural steel item is not specified as Pay Plan Quantity.

In the SiteManager / Daily Work Reports / Work Items tab / Remarks Bubble, provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown.

507.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

Verify that all items previously installed have the proper identifying marks or certifications and that all required certifications have been received from Materials Division.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the change order (i.e. description, explanation, attachment, etc.).

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantities paid equals the plan quantity.

C. Protection of the Work

Perform a final check of the bearing assemblies to ensure that full contact and bearing is made between the beams and the plates and between the plates and the pads. Contact Bridge Division if any irregularities are observed, and require corrective work based on Bridge Division's recommendations.

If required on the Project, verify that the bearing assemblies and any exposed steel items have been painted utilizing the approved paint system proposed by the Contractor.

CHECKLIST – BEARING ASSEMBLIES

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Surface is clean and free of cracks.					
All required certifications have been received from Materials Division.					
Materials have the proper identifying marks.					
Bearings are the proper type for the structure.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Bearing plates are positioned to the correct grade and superelevation and are in full contact with the bottom flange of the girder.					
Beveled bearing plates have correct orientation.					
Temperature corrections are addressed, as applicable.					
Paint and/or primer are removed from weld location prior to welding.					
Welders are ODOT certified.					
Contractor's paint system conforms to Contract requirements.					
Elastomeric or bonded bearing pads are not exposed to temperatures greater than 400 degrees F.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Full contact and bearing exists between the beams and the plates, and between the plates and the pads.					

SECTION 508 – CONCRETE CULVERTS

508.01 GENERAL

This work consists of constructing concrete culverts (reinforced concrete boxes, precast concrete boxes, and precast concrete arches).

508.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- The source of materials and concrete mix designs, and verify that the concrete plant has a current certification.

- When precast culverts are used, the Contractor must provide the source of precast members as well as the bedding material to be used. Also, ensure that shop drawings have been submitted to the appropriate Design Division for approval.

- For box extensions, the Contractor's method for extending the existing structure.

- Contractor's responsibility for falsework design and construction.

- If falsework is taller than 14 feet, working drawings must be submitted in accordance with Section 105.02 of the Standard Specifications.

- Any "phased" construction that may be required, including traffic control issues and detours.

- Contractor's plan for diversion of the existing stream during construction, if necessary.

- For "broken back" or "drop" structures, Contractor's plan to maintain stability of this area.

- Need for approval from the Resident Engineer for stream bed disturbance, work road locations, and disposal of excess excavation.

- Contractor's responsibility to notify the Resident Engineer when excavation is ready for inspection and prior to beginning backfilling operations.

- Contractor's responsibility to comply with the excavation, embankment and erosion control requirements in Section 501 of the Standard Specifications.

B. Acceptance of Materials

1. Precast Structures

Inspection at the fabrication plant site will be handled by Materials Division or its representative.

Acceptance at the fabricator's facility, denoted by an inspection stamp, does not prevent subsequent rejection. The Resident Engineer may reject materials not meeting Contract specifications, and precast structures damaged during delivery or by improper handling. The Contractor must immediately replace or correct rejected materials and work.

Ensure that the source for the bedding material is on the Approved Products List for the appropriate material. Typically, this is miscellaneous aggregate sources or coarse aggregate for hydraulic cement concrete.

2. Cast-in-Place Structures

Acceptance of materials for cast-in-place structures will be performed in accordance with the appropriate pay items for structural concrete and reinforcing steel as discussed in Section 509 and Section 511 of this Manual.

C. Preparatory Work and Contractor Work Plans

The Contractor's Professional Engineer shall determine the need for falsework drawings. If the falsework structure is taller than 14 feet, working drawings will need to be prepared by a registered professional engineer as per Section 502.04.A(1) of the Standard Specifications.

Ensure that the Contractor complies with applicable environmental regulations, including the United States Army Corps of Engineers 404 Permit (included in the Contract), as well as Sections 220 and 501 of the Standard Specifications.

Discuss the Contractor's proposed staking operations and whether or not that information will be provided to the Resident Engineer. Determine if conditions have changed and whether the structure will function as planned in this location, or if adjustments are necessary. Ensure that sufficient data is available for quantity calculations (original cross sections / ground line).

D. Safety and Environmental Issues

In some types of soil, it is necessary to provide shoring, or to slope the ground beyond the neat lines shown in the Project Plans or Standard Drawings in order to avoid caving. The Contractor's slope, shoring, and trenching plan must conform to the Occupational Safety and Health Administration (OSHA) standards. Therefore, all excavations will automatically be referred to the OSHA Standards for excavation. This requirement is necessary for the safety of the inspection personnel as well as the Contractor's personnel.

508.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

1. Precast Structures

Precast structures are inspected by Materials Division or its representative during fabrication and are stamped with markings to indicate compliance with specifications prior to shipment. The Residency Project Inspector must complete the material test template for acceptance of this item. [Document in Template AM5002].

Ensure that the source for the bedding material is on the Approved Products List for the appropriate material. Typically this is miscellaneous aggregate sources or coarse aggregate for hydraulic cement concrete. Perform applicable tests (coarse cover aggregate in accordance with Section 703.06.B(1) or coarse aggregate size No. 8 in accordance with Section 701.06 of the Standard Specifications) on these materials to determine gradation in accordance with AASHTO T 27. [Document in Template T 27].

Acceptance of materials for backfill of precast structures will be performed in accordance with Section 501 of this Manual.

2. Cast-in-Place Structures

Acceptance of materials for cast-in-place structures will be performed in accordance with the appropriate pay item for backfill material, structural concrete and reinforcing steel as described in Sections 501, 509 and 511 of this Manual.

B. Equipment and Methods

Ensure that the Contractor uses equipment sufficient to construct culverts in an adequate manner. This includes use of lifting equipment of sufficient size to place precast members safely and hoisting equipment that will not damage the section or the bedding material.

C. Construction Operations

1. General

Ensure that all excavation is performed in accordance with Section 501 of the Standard Specifications and this Manual. Ensure that the bearing material is stable, consistent, and suitable to withstand the weight of the culvert and any embankment to be placed over it. All unstable material must be removed in accordance with Section 501 of the Standard Specifications and Section 501.03.C.1 of this Manual.

2. Curtain Walls

Construction of curtain walls on culvert footings may be a problem because of the difficulty in maintaining the excavation in proper condition while placing concrete. If material to be excavated is of such nature that neat lines for the curtain wall cannot be maintained, the Contractor may form the curtain wall. Mud must be prevented from working up into the concrete. On Local Government projects only, sheet piling may be used for the construction of curtain walls, only when the soil conditions warrant and with the approval of Bridge Division.

3. Bedding Material

When required by the Contract or warranted by site conditions, the Contractor is to provide at least 4 inches of bedding material beneath concrete box culverts. Bedding material must meet the requirements for Class B bedding in accordance with Section 613.04.C of the Standard Specifications. Even though it may not be required in the Contract, the Contractor may use, at no cost to the Department, some type of bedding (aggregate base, Class 'C' concrete, etc.) to stabilize the foundation material and create a suitable work platform.

4. Precast Concrete Members

Before allowing the Contractor to place precast concrete members, ensure that the bedding material and/or foundations have been constructed as specified. Verify quality of material, dimensions and densities if required. Ensure that the foundation has not been contaminated (e.g., silt from flooding, damage by Contractor's equipment, etc.)

Inspect precast concrete members when they arrive onsite for damage and quality of fabrication as thoroughly as time and conditions allow. Verify that the precast concrete members have been stamped with acceptable ODOT inspection markings. If the member has been stamped with '105.03,' there may be special conditions for its use that should be verified prior to its placement. Do not accept un-stamped members. Inspection should include areas that look like they were patched and cracking. Cracking larger than a 'hairline' width is not acceptable and Bridge Division should be contacted for guidance. The Contractor must correct damaged sections at no additional cost to the Department.

Ensure that the hoisting equipment to be used will not damage the precast concrete members or the bedding material. The Contractor should begin placing the precast concrete members at the downstream end of the structure. Before the member is lowered into place, ensure that the ends of the precast concrete members are free of concrete dust, dirt, mud etc. to allow proper adhesion of the joint sealant material. Precast concrete members should be lowered slowly as they are placed into their final position.

Ensure that the precast concrete members are joined in accordance with Section 613.04.H of the Standard Specifications and the following:

a. Joint material is either Flexible Watertight Gaskets or Flexible Cellular Seals in accordance with Sections 726.01.B(2) and (3) of the Standard Specifications.

b. The ends are fully inserted and the inner surfaces are flush.

c. The joint sealant material has not come loose.

d. The joints are even and watertight.

e. The inside of the members are free of joint material.

f. The members are placed to the line and grade shown on the Plans.

5. Cast-In-Place Concrete Structures

Before allowing the Contractor to place forms, ensure that the bedding material and/or foundations have been constructed as specified. Verify quality of material, dimensions and densities if required. Ensure that the foundation has not been contaminated (e.g. silt from flooding, damage by Contractor's equipment, etc.).

Verify the following:

a. Forming is performed in accordance with Section 502 of this Manual and the Standard Specifications

b. If the barrel length is longer than 100 feet, construction joints must be installed at intervals of 60 to 100 feet in length. Construction joints may be installed in culverts from 60 to 100 feet long. The dimensions of construction joints must be as shown in the Plans.

c. When an emergency arises, construction joints shall be placed as directed by the Inspector. If there is some doubt as to the proper location of the joint, contact the Resident Engineer.

d. Construction joints are constructed in accordance with Section 509.04.D of the Standard Specifications, and the reinforcing steel extends through the joint at least 18 inches and laps 18 inches with the longitudinal reinforcing steel in the adjoining section.

e. Reinforcing steel is placed in accordance with Section 511 of this Manual and the Standard Specifications

f. Concrete is placed and cured in accordance with Section 509 of this Manual and the Standard Specifications

g. Forms are removed in accordance with Section 502 of this Manual and the Standard Specifications

6. Backfilling Culverts

The Inspector’s duties include the following during structure backfill:

a. Do not allow the Contractor to place backfill against any cast-in-place structure until the concrete reaches the required compressive strength in accordance with Section 509.04.I(2) of the Standard Specifications.

b. Ensure that the proper type of backfill material is used as required by the Plans: CLSM, Granular, Select or Unclassified. The material must be free of objectionable material and conform to gradation and plastic index. Objectionable materials include frozen lumps, chunks of clay, vegetation, foreign material, form lumber, rocks larger than 3 inches, and degradable or hazardous matter.

c. Inspect the earthen backfill to ensure it is brought up and compacted uniformly around the structure and in layers no greater than 6 inches in depth after compaction. It is advisable to mark the wall or area being compacted in 6-inch increments as each lift is placed in order to ensure proper lift thickness. Care should be taken to extend the compacted area as far as necessary in order to notch into firm material.

d. Ensure that backfill placement on one side never reaches more than 2 feet above backfill placed on any other side. Rocks larger than 3 inches must not be placed against concrete surfaces.

e. When specified in the Plans, or approved by the Bridge Division as an alternative, the Contractor may use a CLSM backfill material that conforms to the requirements of Section 701.19 of the Standard Specifications. When CLSM backfill is used, ensure it is adequately fluid and is placed so that it completely fills the area around the structure. One of the advantages of CLSM backfill is that it provides adequate support on the underside of pipes where compaction of ordinary backfill material is difficult. The Contractor must avoid “floating” the culvert. Do not allow CLSM backfill to be placed in lifts greater than 4 feet in thickness, to allow for adequate curing (bleeding) of the material and to prevent overturning any vertical elements due to excessive fluid pressures. It is advisable to mark the wall or area being backfilled in 4-foot increments as each lift is placed in order to ensure proper lift thickness.

f. Ensure that all conditions described in the specifications are met before permitting “ponding” and “jetting.” “Ponding” means flooding the backfill material for a period of time (by erecting dams or dikes) so that water will pond on the material. “Jetting” means forcing water into the layer of backfill material through a small diameter pipe. Ponding alone is not permissible because it does not give uniform or adequate consolidation. Pressure jets must be inserted at the bottom of the backfill material at close, uniform intervals. Do not allow the Contractor to use ponding and jetting while it is backfilling behind abutments or wingwalls. Prohibit the use of any compacting equipment or methods that may displace or damage structures or otherwise adversely affect foundations or adjacent embankments.

g. Ensure that the Contractor places pervious backfill material around underdrain pipe as specified, and ensure that the underdrain pipe is not being crushed during compaction.

h. Do not allow the Contractor to place backfill material adjacent to a cast-in-place concrete structure until the concrete has developed the minimum strength specified for that structure. Section 509.04.I(2) of the Standard Specifications requires that a minimum compressive strength of 80% of the design compressive strength be obtained. In no case shall backfill occur before 72 hours after casting. Use field cured cylinders for determining compressive strength.

D. Safety and Environmental Considerations

To help ensure worksite safety during construction operations, the Inspector's duties include the following:

1. Do not allow personnel to stand or park equipment too close to the edge of any excavation.

2. Consider advising the Contractor to construct a pad if needed to provide adequate stability for a crane in soft or yielding material.

3. Ensure that the Contractor's crane operations include maintaining a safe distance from overhead power lines and not over extending the boom.

4. Do not allow placement of excess material in the stream bed or structures.

5. Ensure worksite is protected in accordance with the USACE 404 Permit requirements and SWPPP (Stormwater Pollution Prevention Plan).

6. Discuss OSHA requirements as needed with the Contractor.

7. If suspected hazardous materials are encountered, contact the Resident Engineer for Environmental Programs Division action.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location or Structure Number and the type of work being performed.
- Quantity and classification of material excavated: planned and/or undercut.
- Quantity and classification of material backfilled: unclassified, select, granular or CLSM.
- When the foundation is approved for the placement of forms, rebar, or concrete as per section 501.04.A(2)(e) of the standard specifications.
- If a pre-pour inspection occurred and who was in attendance and list any corrective actions identified.
- Quantity and classification of concrete placed.
- Whether or not proper curing method is being performed and note any deficiencies observed and corrective actions taken. Document curing method and length of time cured.
- When the surface finishing is performed and the Class of surface finish applied.
- Any conditions requiring corrective actions, and individual contacted and their recommendations
- Document who performs the corrective actions
-

F. Measurement and Payment

1. Cast-in-Place Concrete Box Culverts

Measurement and payment for the items of work required for the construction of cast-in-place concrete box culverts (i.e. excavation and backfill, reinforcing steel and dowel bars, and concrete) will be in accordance with sections 501, 511, and 509, respectively, of the standard specifications and this manual.

(a) Precast Concrete Box Culverts

Payment for precast concrete box culverts will be made utilizing the contract unit prices for the relevant pay items (i.e. reinforcing steel and dowel bars, and concrete) and quantities as determined by field measurements for cast-in-place concrete box culverts. If your project has a pay item for precast concrete box culverts paid by the LF, documentation will be performed within the SiteManager / Daily Work Reports / Work Item tab / DWR Template. When utilizing the DWR Template document as follows:

1. Select the appropriate pay item from the list of contract pay items.

2. Open the ‘DWR Templates’ icon in the toolbar.

3. Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to be used as the method of documentation for the work performed.

4. In the appropriate field, enter the descriptive location (i.e. Structure #) or the station to station extents and location.

5. If the actual structure length is different than the Station Length, place that measurement in the Measured Length field, and an explanation is required in the Remarks field.

6. For additional locations, select the 'New Row' button.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown.

(b) Removal of Culvert End

The only pay item associated with this section of the standard specifications and considered for measurement and payment under this section is "Removal of Culvert End".

When this item is Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Work Items tab or in the change order (i.e. description, explanation, attachment, etc.).

Documentation of this item will be performed within the SiteManager / Daily Work Reports / Work Items tab.

1. Select the appropriate pay item from the list of contract pay items.

2. In the appropriate field, enter the descriptive location (i.e. Structure #10 – Left End) or the station and location.

3. In the Placed Quantity field enter the number of culvert ends removed. This quantity will either be as shown on the plans or as actual counted in place, if the removal of culvert end item is not specified as Pay Plan Quantity.

In the SiteManager / Daily Work Reports / Work Items tab / Remarks Bubble, provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown.

508.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

Acceptance of materials for structures will be performed in accordance with the appropriate pay item for backfill material and structural concrete in Sections 501 and 509 of this Manual.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

Ensure the placement and compaction of the backfill material has not damaged the structure or underdrain pipe, temporary erosion control measures or other permanent work.

Check the drainage structure and stream bed to ensure there is no soil or debris accumulation.

Bank cuts and work roads must be restored to their original shape, density and condition.

When less than 10 feet of fill has been placed on the culvert, limit the construction loads (earth moving equipment, cranes, etc.) to the legal load limits.

CHECKLIST – CONCRETE CULVERTS

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Concrete plant has current certification.					
Contractor's proposed sources of materials, including bedding material, are acceptable.					
Contractor provides working drawings prepared by a registered professional engineer for falsework structures taller than 14 feet.					
Contractor's sloping, shoring, and trenching plan complies with OSHA requirements.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
General:					
Contractor complies with applicable environmental permits, including USACE 404 permit.					
Bearing material is stable, consistent, and suitable to support the load of the culvert and the embankment to be placed over it.					
Specified type of backfill is used.					
Backfill is free of objectionable material.					
Precast Concrete Members:					
Precast members bear the acceptable ODOT inspection markings.					
Contractor uses lifting equipment of sufficient size to place precast members safely and without damage to the section itself or the underlying bedding material					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Ends of precast members are free of dirt and dust that would prevent proper adhesion of the joint sealant.					
Joints are even and watertight.					
Members are placed to the lines and grades shown on the plans					
Cast-in-Place Concrete Structures:					
Construction joints are constructed in accordance with Section 509.04.D.					
Concrete is placed and cured in accordance with Section 509.					
Backfill is not placed until the concrete has achieved a minimum compressive strength of 80% of the design strength and in no case before 72 hours after casting.					
Backfill is brought up and compacted uniformly around the structure in layers no greater than 6 inches after compaction.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Culvert and stream bed are free of soil and debris contamination.					
Backfill operations have not damaged the culvert or adjacent work.					
Surrounding ground has been restored to original conditions.					

SECTION 509 – STRUCTURAL CONCRETE

509.01 GENERAL

This work consists of providing, placing, finishing, and curing concrete in bridges, culverts, and other structures.

509.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Source of materials and concrete mix designs (refer to Section 701.01 in the Standard Specifications) and verify that the concrete plant has a current certification.

- Contractor's responsibility to provide at least two thermometers on the Project that can record the maximum and minimum temperatures within 5 degrees F. The Contractor must install the thermometers and submit the temperature data as directed by the Resident Engineer.

- The Contractor is not to place structural concrete until a pre-pour inspection is held and approved by the Inspector. Agree on weather parameters that will be used for "go" or "no-go" decisions both prior to and during the placement activity. The Inspector must be present for all concrete pours.

- Procedures for introducing admixtures during mixing operations need to be discussed and formalized. For example: How and where will the air entraining agent be introduced? There is a growing concern that placement location of admixtures is causing significant variability in mixes. The plant monitor must watch and document how admixtures are introduced during mixing.

- Method and frequency of acceptance testing during any placement. Inform the Contractor what is expected if non-acceptable material is found during placement.

- Placement method and any adjustments that may be required.

- For non QA/QC structural elements, pay factors for acceptance of concrete that fails to meet the specification requirements for strength and air are addressed in Section 509.06 of the Standard Specifications.

B. Acceptance of Materials

1. Concrete Mix Design

For structural concrete, the Contractor will submit its proposed concrete mix designs. The Resident Engineer will approve the concrete mix design in accordance with Section 701.01.C of the Standard Specifications or as amended by the QC/QA Special Provision for bridge deck acceptance, if applicable. As soon as practical, the Residency will obtain sufficient samples of aggregates to be utilized and perform applicable tests on these materials.

2. Concrete Plants

The Resident Engineer will inspect and certify the proposed concrete plant in accordance with Section 414.03.A of the Standard Specifications and will submit this information to the Materials Division. If a portable plant is mobilized to the Project, the Resident Engineer must notify the Oklahoma Department of Environmental Quality (ODEQ) and the Materials Division. The purpose of such notice is to ensure that the plant(s) are properly permitted and inspected for emissions by ODEQ, and that they are accurately tracked within ODOT's databases. When a plant is being installed to produce for a Project in your Residency notify:

Oklahoma Department of Environmental Quality
Air Quality Division
P.O. Box 1677
Oklahoma City, OK 73101-1677
Phone: (405) 702-4100
Fax: (405) 702-4101

and

Oklahoma Department of Transportation
Materials Division
Independent Assurance Branch
200 N. E. 21st Street
Oklahoma City, OK 73105
Phone: (405) 521-2677
Fax: (405) 522-0552

In the notice, list the project number and the location and type of plant (concrete or asphalt).

3. Sources of Materials

The Contractor will submit its proposed sources of materials. The Residency will verify that the proposed sources of materials are on the Approved Products List (APL). If a proposed source is not on the APL, the Resident Engineer must contact Materials Division immediately. Verify the APL for the following:

- Structural Concrete
  - Portland cement (specify type)
  - Supplementary Cementitious Materials (specify type)
  - Admixtures (specify type)
  - Coarse aggregate

   - Fine aggregate (natural or blended)

- Curing Materials
- Concrete Surface Finish Material
- Waterstops [add link]

The Residency will verify that the proposed water source is from an approved ODEQ public water source. If not, the Contractor must provide verification that the water source complies with the requirements of Section 701.04 of the Standard Specifications.

C. Preparatory Work and Contractor Work Plans

Consider the following inspection guidelines before concrete placement begins.

1. Mix Design

Know what class of concrete is required in the structural element being placed, and ensure that the Contractor has obtained an approved mix design. Know the requirements for slump, air, and admixtures, including type and quantity. Mix designs must comply with Section 701.01 of the Standard Specifications.

2. Pouring Schedule/Sequence

The Resident Engineer is responsible for approving pouring sequences and procedures. Know the pouring schedule from central or transit mixers. Consideration should be given for specification requirements for form removal and application of loads.

3. Time and Weather Requirements

Know the specified time limitations on placing concrete. Know the limitations and requirements for placing concrete during cold weather. Verify that the Contractor is adequately prepared to protect fresh concrete from damage due to inclement weather (e.g., rain storms, freezing) in compliance with Section 509.04.B of the Standard Specifications.

4. Formwork

Check lines, grades, and clearances of formwork, reinforcing steel, and embedded fixtures for compliance. Verify that all dirt, chips, sawdust, water, and other foreign materials have been removed from within the formwork. Wood forms should be thoroughly moistened with water prior to the concrete pour. See Section 502.04.B of the Standard Specifications for additional guidance on formwork.

5. Doweling into Existing Concrete

When required, check that reinforcement dowels are properly installed at the correct locations in accordance with Section 509.04.D(3) of the Standard Specifications. Ensure that dowels are not used in overhead applications. Ensure that the existing concrete structures are clean.

D. Safety and Environmental Issues

Discuss with the Contractor its plan to protect workers and traffic during construction. At a minimum, the Contractor's plan should address the following:

- Providing fall protection for workers,
- Preventing tools, material etc. from falling on traffic beneath,
- Providing traffic control during construction,
- Providing skin and eye protection for workers, and
- Properly disposing of waste concrete or materials. (Do not allow the Contractor to place concrete or other materials in streams or waterways.)

509.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

1. Concrete Mix Design

Ensure that the Resident Engineer has approved the concrete mix design in accordance with Section 701.01.C of the Standard Specifications. Any changes to the approved concrete mix design, including substitution of material sources, must be approved by the Resident Engineer.

2. Concrete Plants

Ensure that the concrete plant has been certified in accordance with Section 414.03.A of the Standard Specifications.

3. Materials

Ensure that the Contractor has submitted its proposed sources of materials. The Residency will verify that no changes were made from the proposed sources of materials and that they are still on the APL. If a proposed source is not on the APL, the Resident must contact Materials Division immediately.

Document or perform applicable tests as follows:

- Structural Concrete:
  - Portland cement (specify type) [Document in Template AM5001].
  - Supplementary Cementitious Materials (specify type) [Document in Template AM5001].

    - Admixtures (specify type) [Document in Template AM5001].
    - Coarse aggregate – sample and test for appropriate gradation AASHTO T11 and T27 [Document in Template T27].
    - Fine aggregate (natural or blended) – AASHTO T11 and T27 [Document in Template T27].
    - Curing Materials [Document in Template AM5001].

- Concrete Surface Finish Material [Document in Template AM5001].
- Waterstops [add link] [Document in Template AM5001].

The Residency will verify that the proposed water source is from an approved ODEQ public water source. If not, the Contractor must provide verification that the water source complies with the requirements of Section 701.04 of the Standard Specifications.

The Residency will sample and test fresh concrete for the following:

- Slump: AASHTO T119 [Document in Template C94025]
- Temperature : AASHTO T309 [Document in Template C94025]
- Air Content: AASHTO T152 or T196 [Document in Template C94025]
- Compressive strength: AASHTO T22 and T231 [Document in Template C94014]

The Residency will conduct the sampling and testing described above in accordance with the frequency guidelines defined in the Project's Sampling and Testing Checklist generated by SiteManager for the appropriate items. The frequencies may be modified by the Residency personnel. Typical reasons for revising the frequencies would be consistency or inconsistency of the material being produced, size and frequency of placements, visual appearance (yellow concrete, segregation, etc.), QA/QC or other special provision requirements where Contractor tests are used for acceptance purposes.

B. Equipment and Methods

The Contractor's method of concrete placement is of concern to prevent the loss of entrained air. Rough handling of plastic concrete during placement has, at times, reduced entrained air to less than 2 percent, not to mention creating potential segregation problems. While testing at the point of placement should identify such problems, varying placement conditions during the pour can affect concrete conditions significantly.

General conditions that should be avoided ("Points to watch for"), or at least severely minimized, are explained for each concrete delivery system below. If one of the following cannot be avoided, at least be aware of the condition, and be sure to conduct additional testing should any of the conditions present themselves.

1. Crane and Bucket

In the past it was felt the crane and bucket placement method did not adversely affect concrete. This is now in question when viewed from loss of air and potential segregation. Therefore, this method will now also require testing at the placement location, if practical.

Points-to-Watch For:

a. Free fall of unrestrained concrete shall not exceed 6 feet. Free fall in excess of 6 feet can be avoided by removing a section of form work for intermediate placement or by using a tremie.

b. Discharge from the bucket must be controllable.

c. Cross section of the drop chute should allow it to be inserted into the form work without interfering with reinforcing steel.

2. Belt Placement

Belt equipment is typically used to convey concrete to a lower, horizontal, or somewhat higher level. This method of concrete placement, while allowed by the specifications, is discouraged due to the potential for loss of mortar and segregation of material.

Points-to-Watch For:

a. Conveyor belt systems must be less than 550 feet, as measured from end to end of the belt assembly.

b. A hopper, chute, and deflectors should be used at the discharge end of the conveyor belt so that the concrete drops vertically.

c. The number and distance of drops between belts should be kept to an absolute minimum. Drops tend to encourage segregation and reduce entrained air.

d. As belt conveyors are removed from the line (i.e., as on deck pours), recheck the "as placed" air content.

e. Be sure all mortar is being removed at the discharge. (No mortar should be on the return belt.)

f. Any spillage must be immediately removed and corrective actions taken to prevent further occurrence.

g. Check discharge for potential segregation problems.

h. In adverse weather (hot and/or windy conditions), long belt runs need to be covered.

3. Pump Placement

The mobile pump with hydraulic placing boom is economical to use in placing both large and small quantities of concrete. These units are used to convey concrete directly from a truck unloading point to the concrete placement area.

Points-to-Watch For:

a. Typically, pumps are initially flushed with a thin water/cement mortar mixture to coat the lines. This slurry can not be incorporated into the work and must be disposed of properly.

b. Pumping should be at a constant rate, with pipelines kept full of concrete. High air loss can occur when concrete is allowed to free-fall inside pump lines.

c. To the extent possible, having vertical and steep angles in the pump pipelines should be avoided. Steep angles and slow placement rates are probably the worst conditions for minimizing air loss and segregation. If this condition occurs:

    1. Recommend that the Contractor relocate the pumper, thereby minimizing lift angle.

    2. If discharge is not maintaining a constant flow with the partial concrete head in the pipe, request the pump operator to place a reducer and short section of hose at the discharge end. The purpose is to avoid free falling concrete from impacting the deck or forms at high velocity.

d. If the above condition is unavoidable, watch and test the discharge frequently for air loss and potential segregation. Watch and test the air content frequently, when drop may exceed 6 feet.

e. Concrete should be pumped with the discharge hose being as flat as possible (or at least with minimal down angle). This practice will help maintain a charge on the pump pipeline and eliminate excessive vertical drop, which will aid in reducing the loss of air and segregation of the concrete.

C. Construction Operations

1. Concrete Placement

Consider the following inspection guidelines during the placement of concrete:

(a) Load Tickets

Check the information presented on load tickets to verify compliance with the proper mix design for the structural element being poured. Also ensure compliance with the time limitations required by Table 509:1 of the Standard Specifications.

(b) Mix Proportion Changes

Consult the Materials Division regarding any changes to mix proportions.

(c) Adding Water

The Contractor must exercise care if adding water at the Project site, and should be avoided whenever possible.

Ensure that the quantity of water added to the concrete mix at the site is properly recorded on the load ticket. Verify compliance with specified procedures for adding water (e.g., minimum mixer drum revolutions of 30 in accordance with Section 414.04.C of the Standard Specifications; maximum water/cement ratio required by Table 701:1 of the Standard Specifications).

(d) Mixer Revolutions

Check that mixer revolutions are performed at mixing speed. Concrete that is completely mixed in a truck mixer must have 70 to 100 revolutions at the mixing speed designated by the manufacturer in accordance with AASHTO M 157.

(e) Chutes and Troughs

Where required, verify that chutes or troughs are used properly. Chutes should be lined with smooth, watertight material. If working around steep slopes, the Contractor should equip the chutes with baffles or reverses.

(f) Segregation

Check that the Contractor's method of placing concrete minimizes segregation. Unconfined concrete must be dropped from a height of less than 6 feet. Concrete may be confined by using a tremie (tube fitted with a hopper head) or pump, which will prevent mix segregation and mortar spattering.

(g) Construction Joints

Verify that construction joints are properly formed at the correct location. Check that construction joints are cleaned and maintained free of debris and loose material. Verify that construction joints are made where required by the Contract. Reinforcing steel must extend through joints. The Contractor may place emergency construction joints as approved by the Resident Engineer, and add steel dowels across the joint at no additional cost to the Department.

(h) Form Stability

Concrete must be placed in horizontal layers less than 18 inches thick. Ensure the vibrators consolidate and merge new layers with the previous layer. When placing concrete, the Contractor must not exceed the design loading for forms. Monitor false work for any movement and/or loss of concrete during placement. Check forms for obvious signs of weakness, such as panel bulges and settlement. If these conditions are observed, stop the concrete placement, determine the cause of the movement, and direct the Contractor to make adjustments before continuing.

(i) Pour Sequence

Verify conformance with the designated concrete pour sequence.

(j) Reinforcing Steel

Monitor the operation for reinforcing steel displaced by workers, equipment or concrete during the pours. Check that proper cover and clearance is maintained. When epoxy coated reinforcing steel is used, ensure that the placement operation does not damage the epoxy coating. Prior to placement of additional concrete, verify that extraneous mortar is cleaned from exposed reinforcing steel.

(k) Cast-In-Place Anchor Bolts and Dowel Bars

Where required, verify that cast-in-place anchor bolts and dowel bars are properly installed at the correct locations. Ensure that they are not moved during the placement and consolidation of the concrete.

(l) Time and Temperature Limitations

Monitor the operation to ensure that the time limitations for placement and consolidation in Table 509:1 of the Standard Specification are not exceeded.

Most forms are not designed to handle the full head pressure of concrete. Therefore, the concrete must be placed slowly enough to allow the bottom concrete to gain initial set before the top concrete is placed. This must be considered in timing delivery of concrete to ensure that time limitations in Table 509.1 of the Standard Specifications are not exceeded.

Know the requirements for cold-weather concreting specified in Section 509.04.B(4) of the Standard Specifications. Concrete must be maintained at the minimum specified temperature for the minimum number of curing days. Protect the concrete from environmental damage during placement and curing. Replace or repair frozen or damaged concrete.

Concrete must be placed with a temperature from 50 to 90 degrees F (85 degrees F for bridge decks). Measure the concrete temperature immediately before placement. Concrete may be placed against forms, the ground, or reinforcement with a temperature from 35 to 100 degrees F.

The Contractor must have at least two thermometers onsite that can record the maximum and minimum temperatures within 5 degrees F. The Contractor must install the thermometers and submit temperature data as directed by the Resident Engineer. Readings must be reported and thermometers reset daily.

(m) Consolidation

Ensure that concrete is placed close to its final position. Do not allow the Contractor to use vibrators to move a mass of fresh concrete. Mechanical vibrators must be used to consolidate the concrete immediately after placement. The Contractor must provide at least one spare vibrator in case of breakdown. Consolidation must be performed in accordance with Section 509.04.C(4) of the Standard Specifications. Do not allow the Contractor to vibrate into layers of concrete that have become non-plastic.

(n) Underwater Placement

When underwater placement is allowed or required, ensure that the work is performed in accordance with Section 509.04.C(5) of the Standard Specifications. It is important that the concrete does not flow through the water during placement. Concrete must be placed in a compact mass to prevent segregation. Monitor the level of the concrete to ensure that the outlet of the tremie or the pump hose remain below the surface of the concrete. Ensure that the tremie tube or pump hose remains full of concrete during placement to maintain a continuous flow of concrete. Ensure that the surface of the water is not agitated. If the water does become agitated, it is an indication that the tremie or pump hose has come out of the concrete and corrective action must be taken. If water enters the tube, the Contractor must withdraw the tremie and reseal the discharge end.

Dewatering may proceed after the test specimens cured under similar conditions indicate that the seal concrete is strong enough to resist the planned loads. Before placing foundation concrete on the seal concrete, ensure all laitance and other unsatisfactory material is removed from exposed surfaces without damaging the concrete.

(o) Visual Appearance

Prior to the progression of construction or curing, visually inspect the placed concrete for variations in appearance, including color, texture, consolidation, etc. Changes in the appearance could indicate inconsistencies in the materials incorporated in the concrete or with its handling and placement. If changes in appearance are observed, bring them to the Resident Engineer's attention as additional sampling, testing and evaluation may be warranted.

Verify that the concrete meets the planned lines and dimensions for the work.

2. Concrete Curing

The requirements for the allowable methods of curing structural concrete are defined in Section 509.04.F of the Standard Specifications, and must be strictly enforced. Closely monitor the operation for compliance to all specifications. Simply stated, the intent of the specification is to maintain the surface of the concrete in a moist condition for the minimum curing period, which includes the period during which the finishing operation is performed. Check that that the Contractor is adequately prepared to protect the concrete and maintain the surface in a moist condition, especially during hot, windy or sunny weather. Consider the following guidelines:

(a) Temperature Requirements

Concrete must be maintained at the minimum specified temperature (50 degrees F) for the minimum number of curing days. The Contractor must protect the concrete from environmental damage during curing and replace or repair frozen or damaged concrete at no cost to the Department.

If the Contractor uses heaters, ensure that the heaters and ducts are placed in a manner that prevents fire hazards and excessive localized drying, and that the exhaust flue gases from combustion heating units are vented to the outside of enclosures. Ensure that the heat is applied and withdrawn gradually and uniformly so the concrete surface does not heat to more than 90 degrees F before setting, and that when removing protection, the temperature does not vary by more than 20 degrees F in 8 hours.

(b) Curing Method

Verify that the Contractor's proposed curing method for each element is in accordance with Section 509.04.F of the Standard Specifications. If the forms-in-place method is not used for the entire curing time of the placed element, then one of the other curing methods must be used for the remainder of the curing time.

(c) Curing Compound

Where curing compound is applied, ensure the following:

- The material has been approved for use on the Project. Type 2 (white pigmented liquid membrane) must be used on visible bridge deck and approach slab surfaces. All other surfaces may use Type 1-D (clear with red fugitive dye) or Type 2 (white pigmented liquid membrane) for curing.

- The minimum application rate is 1 gallon per 160 square feet. The application should leave the entire surface covered until gray (concrete) is no longer visible.

- The equipment continuously agitates the solution and produces a fine spray.

Membrane-curing solutions that contain pigments must be mixed thoroughly before use. If more than one application is required, the successive coats must be applied within 30 minutes and at right angles to the previous application.

A new coat of curing compound must be applied if rain damages the membrane during the curing period.

Do not allow the use of the liquid membrane method for rub-finished surfaces, as this will prevent the finish from bonding to the concrete. Any curing compound on construction joint must be removed by sandblasting before the next concrete placement against the joint. Check all reinforcing steel protruding from the current pour to ensure that it is protected from the liquid membrane-curing compound, and prior to placement of additional concrete, ensure that any compound is removed from the reinforcing.

3. Concrete Finishing

Closely monitor the finishing operation to ensure that all specified finishing requirements are being met. Various classes of concrete finish may be specified for any given structure, and the designated finish must be applied properly at the designated location. Do not approve a structure until the finishing operation has been thoroughly inspected and found acceptable. A structure’s appearance is only as good as the quality incorporated in the surface finish. Consider the following guidelines:

(a) Form Removal

The concrete must be allowed to cure to a strength that will allow the structural member to support itself without damage when formwork and falsework are removed. Minimum strength criteria and number of days required before removal of forms will be in accordance with Section 502.04.C of the Standard Specifications. The Resident Engineer may shorten the time for form removal specified in Table 502:2 of the Standard Specifications when concrete attains 80% of the design strength. The specimens for determining early strength requirements must be stored with the 'mass' concrete. They must be representative of the temperatures the concrete experiences. If the specimens are stored in a 70 degree water bath while the mass concrete has been in 50 degree weather, the rate of strength gain will be much faster in the 70 degree bath than the mass concrete. If the forms are removed based on a test like this, the concrete could fail. Maturity meters are another good way to measure in-place concrete strength gain.

(b) Temperature Considerations

When a Class 6 or Class 7 surface finish is designated, verify that the concrete surface temperature is within allowable limits before application. On all other classes of surface finish, ensure that the concrete surface temperature is at least 40 degrees F and remains such until set.

(c) Joints

Pay particular attention to construction and expansion joints during the finishing operation. Joint openings must be maintained free of all mortar and loose concrete.

(d) Surface Preparation

Verify that all formed surfaces are thoroughly cleaned by water and/or sand blasting at the proper time and that all irregular projections are removed. Any curing compound that may have been previously placed must be removed at this time. Ensure as a minimum that a Class 1 Ordinary Surface Finish is applied, which requires that all cavities, honeycomb spots, and broken edges are properly cleaned, saturated with water, and pointed and trued with the specified mortar mixture. Check that structural mortar patches are cured as specified.

(e) Classes of Surface Finishes

Verify that the designated class of finish is properly applied at the correct location. Although a Class 1 finish is not a comprehensive treatment, it is just as important as other surface treatments. Class 1 finishes are applied immediately after form removal.

Except for superstructure soffits, concrete girder bottoms, concrete girder interior faces, and the interior faces of reinforced concrete boxes, ensure that concrete surfaces are finished with a Class 2, Rubbed Finish, unless another Class of surface finish is required by the Contract.

Before the application of a Class 6 or Class 7 surface finish, the concrete surface must have been allowed to cure as specified. When a Class 7 Paint Finish is designated, check that the paint material and color have been approved, and verify the application rate and number of coats for compliance.

D. Safety and Environmental Considerations

Ensure that the Contractor protects workers and traffic during construction. At a minimum, the Contractor should:

- Provide fall protection for workers
- Prevent tools, material etc. from falling on traffic beneath
- Provide traffic control during construction
- Provide skin and eye protection for workers
- Properly dispose of waste concrete and materials. Do not allow the Contractor to place concrete or other materials in streams or waterways.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location or Structure Number and the type of work being performed.
- If a pre-pour inspection occurred and who was in attendance and any corrective actions identified.
- Quantity and classification of concrete placed.
- Whether or not proper curing method is being performed and any deficiencies observed and corrective actions taken. Document curing method and length of time cured.
- When the surface finishing is performed and the Class of surface finish applied.
- Any conditions requiring corrective actions, including the location of the required correction, the individual contacted, and their recommendations.

2. Measurement and Payment

(a) Pay Plan Quantity

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

(b) Cubic Yard Unit of Measure Pay Items

Documentation of these items will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template. Note: The same template will be used for each method of measurement, but the information required will depend on the option selected.

1. Select the appropriate pay item from the list of contract pay items.

2. Open the 'DWR Templates' icon in the toolbar.

3. Select the payment option from the radio button list (3D Measured or Calculated Quantity) that is going to be used as the method of measurement for the work performed.

4. Depending on the option selected, enter the following information:

   a. Three Dimensional Measured Quantity Option.

   This option can be used for progressive payments or for documenting the final quantity of concrete volumes necessary for structures and isolated locations.

      (1) In the appropriate fields, enter both a descriptive location and the station to station extents.

      (2) Input the measured length, width and depth to calculate a volume.

      (3) For additional areas or additional locations, with different dimensions, select the 'New Row' button.

   b. Calculated Quantity Option.

   This option will allow the input of quantities calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), and can be used for progressive payments or for documenting the final quantity of areas. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

(1) In the appropriate fields, enter both a descriptive location and the station to station extents.

(2) In the Calculated Quantity field, enter the calculated quantity (CY) of the item completed.

(3) In the 'Remarks' area provide sufficient information to provide any additional comments specific to the work performed.

(4) In the Book/Folder/Envelope # field provide the location of the documentation for the calculations.

(5) For additional areas or additional locations, with different dimensions, select the 'New Row' button.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

(c) Reduced Payment for Out of Tolerance Compressive Strength and Air Content

If out of tolerance structural concrete is produced and identified by the Residency, the Resident Engineer may request that Bridge Division evaluate whether or not the concrete may be used in the structure. If the concrete is determined to be structurally sufficient, payment for this concrete will be made under the original contract item, and a deduction will be applied in accordance with section 509.06 of the standard specification. These deductions will be documented in SiteManager by Line Item Adjustment or by change order. The calculations for these deductions will be placed in a Book, Folder or Envelope, or as an attachment to the change order.

509.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

1. Compressive Strength

Ensure that the 28 day concrete compressive strength requirements have been met. If the compressive strengths do not meet the specifications, the following actions may be necessary:

a. Contact the appropriate Design Division (Bridge, Roadway, consultant firm, etc.) to verify that the strength achieved will meet the minimum design strength for the structural element. If the minimum design strength is not met, the concrete will need to be removed and replaced at no cost to the Department. If the minimum design strength is met, then the concrete may be accepted at a reduced cost in accordance with Section 509.06 of the Standard Specifications.

b. Check for changes in the appearance of the structural element represented by the compressive strength test, which may indicate inconsistencies in the materials incorporated in the concrete or with its handling and placement. If changes in appearance are observed, bring them to the Resident Engineer's attention as additional sampling, testing and evaluation may be warranted.

c. Extract additional samples by coring in accordance with AASHTO T 24. The compressive strength testing of those samples will be done in accordance with AASHTO T 22. Typically, the Contractor is responsible for extracting the samples and the Materials Division performs the compressive strength test. It is critical that the samples are handled and cured in strict accordance with the AASHTO procedures.

2. Air Content

If the air content did not meet the specifications, the following actions may be necessary:

a. Contact the appropriate Design Division (Bridge, Roadway, consultant firm, etc.) to verify that the air content achieved will meet the acceptable limits for the structural element. If the acceptable limits for the air content are not met, the concrete will need to be removed and replaced at no cost to the Department. If the acceptable limits for the air content are met, then the concrete may be accepted at a reduced cost in accordance with Section 509.06 of the Standard Specifications.

b. Extract additional samples by coring in accordance with AASHTO T 24. The air content of hardened concrete of those samples will be determined in accordance with ASTM C457. Typically, the Contractor is responsible for extracting the samples and the Materials Division performs the hardened concrete air content test. It is critical that the samples are handled and cured in strict accordance with the AASHTO procedures

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work

Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

Prior to allowing construction to proceed, visually inspect the placed concrete for variations in appearance, including color, texture, consolidation, etc. Changes in the appearance could indicate inconsistencies in the materials incorporated in the concrete or with its handling and placement. If changes in appearance are observed, bring them to the Resident Engineer's attention as additional sampling, testing and evaluation may be warranted.

Ensure that the curing requirements are complied with for the specified length of time. Refer to Section 509.04.F of the Standard Specifications.

Monitor thermometers on the concrete elements. If the temperature drops below 50 degrees F, direct the Contractor to take corrective actions.

Form removal will be in compliance with Section 502.04.C of the Standard Specifications.

Protect the concrete elements against premature loading of the concrete as required by Section 509.04.I of the Standard Specifications.

CHECKLIST – STRUCTURAL CONCRETE

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
The Resident Engineer has approved the Contractor's proposed mix design.					
The Resident Engineer has inspected and certified the Contractor's proposed concrete plant.					
Portable plants have been properly permitted and inspected, as applicable.					
The Resident Engineer has approved the proposed pour sequences and procedures.					
The Contractor's proposed sources of materials are acceptable.					
Lines, grades, and clearances of formwork comply with requirements.					
Reinforcing steel and embedded fixtures comply with requirements.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
All foreign materials have been removed from formwork.					
Falsework exhibits no obvious signs of weakness.					
Contractor's methods of concrete placement minimize air loss and segregation.					
Residency is present for all concrete pours.					
Unconfined concrete is dropped from a height of less than 6 feet.					
Construction joints are made where required and kept free of debris.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Concrete is placed in horizontal layers of less than 18 inches in thickness.					
Proper cover and clearance are maintained for reinforcing steel.					
Concrete is placed and consolidated within the time limitations specified in Table 509:1.					
Placed concrete exhibits no variations in appearance.					
Contraction maintains the curing conditions specified in 509.04.F.					
Contractor complies with the specified finishing requirements.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Concrete meets planned lines and dimensions.					
Compressive strength meets specified requirements.					
Air content meets specified requirements.					
Placed concrete is uniform in appearance.					
Concrete is protected against premature loading.					
Waste concrete or materials have been properly disposed of (i.e., not in streams or waterways).					

SECTION 510 – EARTH RETAINING SYSTEMS AND SOUND BARRIER WALLS

510.01 GENERAL

This work consists of constructing earth retaining systems, cast-in-place concrete sound barrier walls, and slopewalls.

510.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- The type of wall the Contractor will be using, and who the fabricator will be, if applicable.
- Contractor must provide working drawings and design calculations for steel sheet piling, alternative earth retaining systems and noise barrier walls, or as required by the Contract.
- If an architectural finish is required on the exposed wall surfaces, the Contractor must submit a sample of the form liner for approval.
- Discuss requirements for backfill material and the Contractor's source of the material. Compliance with electro-chemical requirements will be necessary if steel soil reinforcement is used with an MSE wall.

B. Acceptance of Materials

1. Cast-in-Place Walls and Slopewalls

(a) Concrete Mix Design

The Contractor will submit its proposed concrete mix designs. The Resident Engineer will approve the concrete mix design in accordance with Section 701.01.C of the Standard Specifications. As soon as practical, the Residency will obtain sufficient samples of the aggregates to be used and will perform applicable tests on these materials.

(b) Concrete Plants

The Resident Engineer will inspect and certify the proposed concrete plant in accordance with Section 414.03.A of the Standard Specifications, and submit this information to the Materials Division. If a portable plant is mobilized to the Project, the Resident Engineer must notify the Oklahoma Department of Environmental Quality (ODEQ) and the Materials Division in accordance with Section 509.02.B.2 of this Manual. The purpose of the notice is to ensure that the plant(s) are properly permitted and inspected for emissions by ODEQ, and that they are accurately tracked within ODOT's databases.

(c) Sources of Materials

The Contractor will submit its proposed sources of materials. The Residency will verify that the proposed sources of materials are on the Approved Products List (APL). If a proposed source is not on the APL, contact the Materials Division immediately. Verify the APL for the following:

- Structural Concrete – source for each individual component, in accordance with Section 509.02.B.3 of this Manual.
- Reinforcing Steel
- Curing Materials

2. Precast Walls

The precast wall system must be approved by Bridge Division.

The Contractor is required to submit shop drawings to Bridge Division for approval.

Confirm that the proposed source of precast wall is on the Materials Division Approved Product List (APL) (add link) for the type of wall provided. If the proposed source is not on the APL, contact Materials Division for source approval. Inspection at the fabrication plant site will be handled by Materials Division or its representative. Residency personnel are not required to perform fabrication inspection.

Acceptance at the fabricator's facility, denoted by an inspection stamp, does not prevent subsequent rejection. The Engineer may reject precast wall segments not meeting Contract specifications, or which have been damaged during delivery or installation. The contractor will immediately replace or correct rejected materials and work.

3. Incidental Items

The Contractor will submit its proposed sources of materials for those items that are included in the square yard price for walls. The Residency will verify that the proposed sources of materials are on the APL. If a proposed source is not on the APL, contact the Materials Division immediately. Verify the APL for the following when applicable:

- Pipe underdrain

- Filter fabric
- Pipe underdrain cover material
- Concrete surface finish

C. Preparatory Work and Contractor Work Plans

Ensure that the Contractor submits working drawings and design calculations for alternative earth retaining systems and noise barrier walls, or as required by the Contract. Drawings must be submitted in accordance with Section 105.02 of the Standard Specifications. Drawings must include the information required by Section 510.04.B of the Standard Specifications. Drawings must be approved by Bridge Division before work may begin on the wall system.

D. Safety and Environmental Issues

In some types of soil it is necessary to provide shoring, or slope the ground beyond the neat lines shown in the Project Plans or Standard Drawings in order to avoid caving. The Contractor's slope, shoring and trenching plan must conform to the Occupational Safety and Health Administration (OSHA) standards. Therefore, all excavations will automatically be referred to the OSHA Standards for excavation. This requirement is necessary for the safety of the Inspection personnel as well as the Contractor's personnel.

Discuss Contractor's proposed methods to ensure adequate bracing of the walls to prevent possible overturning onto workers or equipment.

510.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

1. Cast-in-Place Walls and Slopewalls

(a) Concrete Mix Design

Ensure that the Resident Engineer has approved the concrete mix design in accordance with Section 701.01.C of the Standard Specifications. Any changes to the approved concrete mix design, including substitution of material sources, must be approved by the Resident Engineer.

(b) Concrete Plants

Ensure that the concrete plant has been certified in accordance with Section 414.03.A of the Standard Specifications.

(c) Sources of Materials

Ensure that the Contractor has submitted its proposed sources of materials. The Residency will verify that no changes were made from the proposed sources of materials and they are still on the APL. If a proposed source is not on the APL, the Resident must contact Materials Division immediately.

Document or perform applicable tests as follows:

- Structural Concrete – sample and test for each individual component, in accordance with Section 509.03.A.3 of this Manual.
- Reinforcing Steel – accept in accordance with Section 511 of the Manual.
- Curing Materials - ensure that they are provided from an approved source, as shown in the APL. [Document in Template AM5001]

2. Precast Walls

Verify that the precast wall system proposed by the Contractor is the one that is being erected and ensure the following:

- The system and shop drawings have been approved by Bridge Division.
- Precast wall segments are inspected by Materials Division or its representative during fabrication and are stamped with markings to indicate compliance with specifications prior to shipment. The Residency Project Inspector must complete the material test template for acceptance of this item. [Document in Template AM5002].
- Acceptance at the fabricator's facility, denoted by an inspection stamp, does not prevent subsequent rejection. The Engineer may reject precast wall segments not meeting Contract specifications, or which have been damaged during delivery or installation. The contractor will immediately replace or correct rejected materials and work.
-

3. Incidental Items

Ensure that the Contractor has submitted its proposed sources of materials for those items that are included in the square yard price for walls. The Residency will verify that no changes were made from the proposed sources of materials and they are still on the APL. If a proposed source is not on the APL, the Resident must contact Materials Division immediately.

Document or perform applicable tests as follows:

- Compaction of backfill: AASHTO T 310. [Document in Template C95001].
- Soil classification for backfill: AASHTO M 145.
- Gradation for granular backfill or as specified in the approved shop drawing: AASHTO T 27. [Document in Template T 27].

- Form liners: The Resident Engineer will inspect and approve the architectural finish form liner. The appropriate Design Division may be contacted for their assistance.
- Pipe underdrain: Ensure that they are provided from an approved source, as shown in the APL. [Document in Template AM5001].
- Geocomposites: Ensure that the geocomposite complies with the approved shop drawings.
- Filter fabric: Ensure that they are provided from an approved source, as shown in the APL. [Document in Template AM5001].
- Pipe underdrain cover material. Sample and test for gradation. AASHTO T 27. [Document in Template T 27].
- Concrete surface finish: Ensure that they are provided from an approved source, as shown in the APL. [Document in Template AM5001].
- Any MSE retaining wall system required elements, including the following:
    a. Compliance with electro-chemical requirements will be necessary if steel soil reinforcement is used. The Contractor must provide data for resistivity, pH, chlorides, and sulfates using the test procedures in the approved shop drawings.

    b. Ensure the elements provided to construct the wall are in accordance with the approved shop drawings (i.e. straps, pins, clips, joint fillers and sealers, etc.).

    c. Ensure the backfill material properties are in accordance with the design parameters in the approved shop drawings (i.e. friction angle, cohesion and unit weight).

B. Equipment and Methods

Certain wall systems may require very specific sequence of installation or specialized equipment for the erection of the wall system, and the manufacturer's recommendations must be followed.

If an architectural finish on the exposed wall surfaces is shown on the Plans, verify the following:

- A sample of the form liner has been submitted for the Resident Engineer's approval, with working drawings.
- The least possible number of joints in the form liner is used.
- That any damaged form liner is discarded and replaced.

C. Construction Operations

1. General Requirements for Wall Systems

For earth retaining systems and noise barrier walls, ensure that the Contractor uses construction methods in accordance with Section 501, Section 502, Section 509, Section 511 and Section 613 of the Standard Specifications.

The Department will allow alternative designs for earth retaining systems and noise barrier walls, unless otherwise required by the Contract. The Contractor must obtain the Resident Engineer's approval of the working drawings before using an alternative design.

Ensure that the Contractor places backfill material within the lines shown on the Plans, and uses the type of granular backfill for retaining walls required in the Contract.

Ensure that the wall drainage system is installed in accordance with the Plans, working drawings or the manufacturer's recommendation. Failure of the drain to function properly could cause the structure to fail. Check the Plans to determine whether measurement for payment of the wall drainage system is required.

If an architectural finish on the exposed wall surfaces is shown on the Plans, ensure that the work is completed in accordance with the working drawings or Plans.

2. Cast-in-place Concrete Walls

(a) Retaining Wall Placement

The Contractor must not place forms, rebar, or concrete until the foundation is approved.

Unless otherwise required by the Contract, verify that the Contractor casts retaining walls with a 1 percent batter toward the backfill to compensate for wall deflection. Each section within a continuous section of wall must be cast and cured in accordance with Section 509 of the Standard Specifications before backfilling may begin.

(b) Vertical Precast Concrete Wall Elements with Cast-in-Place Concrete Footings

Ensure that the Contractor adequately supports and braces precast wall elements until the footing concrete develops the strength to support wall elements. The work must conform to the requirements of Section 509 of the Standard Specifications.

3. MSE Walls

Ensure that the wall system is constructed in accordance with approved working drawings.

When precast wall segments arrive on the site they should be inspected for damage and quality of fabrication as thoroughly as time and conditions permit. Verify that the precast wall segments have been stamped with acceptable ODOT inspection markings. If the segments have been stamped with '105.03' there may be special conditions for their use and should be verified prior to erection. Do not accept un-stamped segments. Large cracks are not usual or acceptable. Ensure that the wall system is constructed in accordance with approved working drawings.

(a) Backfill Material

The Contractor must provide test reports showing that the backfill material conforms with the following requirements:

- An internal friction angle of at least 34°. The internal friction angle will be determined using the Standard Direct Shear Test in accordance with AASHTO T 236.
- A cohesion factor of 0.
- Unit weight of at least 120 lb/ft^3.
- If using steel soil reinforcement, the Contractor must provide test results (one test per source) for the backfill material to ensure compliance with the electrochemical requirements of Section 510.02.E of the Standard Specifications.

(b) Erection of MSE Walls

Ensure a field representative from the chosen proprietary wall system is available during wall erection. The Contractor is to provide the representative's services at no additional cost to the Department.

(1) Inspection During Erection of MSE Wall

During the Contractor's erection of an MSE wall, verify the following:

a. Panels are handled with lifting devices connected to the upper edge of the panels.

b. Panels are placed in successive horizontal lifts in the sequence shown on the working drawings.

c. When placing backfill material behind the panels, the Contractor holds the panels in a vertical position with temporary wedges or bracing in accordance with the recommendations of the wall supplier.

d. For structures with precast facing panels, the concrete vertical tolerances and horizontal alignment tolerances do not exceed 0.75 inches in 10 feet.

e. Panel offset from adjoining panels does not surpass 0.75 inches.

f. Backfill is placed immediately after erecting each course of panels.

g. Backfill does not damage or disturb the wall materials, or misalign the facing panels. Damaged wall materials will be replaced at no additional cost to the Department.

h. Any misalignment or distortion from placing backfill outside the Contract required limits is corrected at no additional cost to the Department.

i. Backfill is compacted to 95 percent of the maximum density in accordance with AASHTO T 99, Method C or Method D (with oversize correction as specified in Note 7), or as shown on the Plans.

j. Before and during compaction, the moisture of the backfill material is uniformly distributed throughout each layer. Backfill material with a placement moisture content greater than optimum must be removed and reworked.

k. Backfill is placed in lifts of 6 inches or less. The Contractor may use a lightweight mechanical tamper, roller, or vibratory system for compaction within 3 feet of the backface of the wall using at least three passes.

l. At the end of each work day, the last level of backfill is sloped away from the wall to direct runoff, and surface runoff is prevented from entering the wall construction site.

(2) Inspection after Backfill of MSE Wall

After the Contractor completes backfill operations, verify the following:

a. An overall vertical wall tolerance of no more than ½ inch per 10 feet in height is maintained.

b. The plumb and tolerances of the panel row at the face before erecting the next panel row. If the panels do not meet the Contract required tolerances, the Contractor must remove the backfill and reset the panels.

c. Horizontal, vertical, and slope joints are uniform and with openings between panels from 0.5 to 1.25 inches wide.

4. Slopewalls

The Resident Engineer will determine the final number and location of construction joints in the field before the Contractor may begin construction of the slopewall. The placement of horizontal construction joints in the slopewalls will not be allowed. Vertical construction joints must be spaced less than 10 feet, measured along the top of slopewall. Verify that the various types of joints for the slopewalls and the curing are in accordance with Section 610 of the Standard Specifications.

Ensure that the type, number, and spacing of supports for reinforcing steel are adequate to minimize sagging and displacement, and provide adequate cover.

5. Steel Sheet Piling

(a) General

Ensure that the Contractor provides sheet piling walls with the minimum section modulus specified in the Plans or working drawings, and that the materials meet the requirements of Section 510.02.C of the Standard Specifications.

(b) Permanent Steel Sheet Piling Walls

Verify that the steel sheet piling is driven and cut off at the pile tip elevation shown on the Plans and in accordance with Section 514.04.C. When specified in the Plans, the steel sheet piling must be braced with waling strips. If painting is required, this must be performed in accordance with Section 512 of the Standard Specifications using a Category “N” paint system.

(c) Temporary Sheet Piling

Ensure that the Contractor furnishes temporary steel sheet piling when shown on the Plans or as needed for phased construction and in accordance with the approved working drawings. Remove and dispose of temporary steel sheet piling when no longer needed.

D. Safety and Environmental Considerations

Ensure that the Contractor follows the OSHA requirements for excavation.

When erecting wall systems, the Contractor must provide adequate bracing to prevent possible overturning onto workers or equipment.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location or Structure Number and the type of work being performed.
- If a pre-pour inspection occurred and who was in attendance and any corrective actions identified.
- Quantity and classification of concrete or steel sheet piling placed.
- Whether or not proper curing method is being performed and note any deficiencies observed and corrective actions taken. Document curing method and length of time cured.
- When the surface finishing is performed and the Class of surface finish applied.
- Any conditions requiring corrective actions, location of correction as well as individual contacted and their recommendations

2. Measurement and Payment

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

Documentation of these Square Yard items will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template.

a. Select the appropriate pay item from the list of contract pay items.

b. Open the ‘DWR Templates’ icon in the toolbar.

c. Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to be used as the method of documentation for the work performed.

d. Select the appropriate method of measurement from the Type radio button options. Depending on the option selected, enter the following information:

1. Two Dimensional Measured Quantity Option.

This option can be used to allow the template to calculate areas for progressive payments or for documenting the final quantity. Typically this option will be used for areas involving simple calculations which will only require length and width.

a. In the appropriate fields, enter both a descriptive location and the station to station extents.

b. Input the measured length and width to calculate an area.

c. For additional areas or additional locations, with different dimensions, select the 'New Row' button.

2. Calculated Quantity Option.

This option will allow the input of quantities calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), and can be used for progressive payments or for documenting the final quantity of areas. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

a. In the appropriate fields, enter both a descriptive location and the station to station extents.

b. In the Placed Quantity field, enter the calculated quantity (SY) of the item completed.

c. In the Book/Folder/Envelope # field provide the location of the documentation for the calculations.

d. For additional areas or additional locations, with different dimensions, select the 'New Row' button.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

Payment for drilled shafts and piling utilized in the construction of retaining walls and sound barrier walls will be made in accordance with Section 516 and 514, respectively, of the Standard Specifications.

510.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

Ensure that the 28-day concrete compressive strength requirements have been satisfied in accordance with Section 509 of this construction manual.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

Care must be taken to protect any filter fabric or drainage systems during the backfill of the wall. The resulting hydrostatic pressure developed by a damaged drainage system could cause failure of the wall. If the filter fabric is damaged, the backfill material could be lost from behind the wall.

The Contractor must protect the concrete walls against premature loading of the concrete and ensure that heavy construction loads are not placed in close proximity to the walls.

Ensure that the Contractor prevents any damage to the walls and any associated drainage systems during the completion of the remaining project.

CHECKLIST – EARTH RETAINING SYSTEMS AND SOUND BARRIER WALLS

Part 1: Preconstruction

Issue	Yes	No	N/A	Comments	Initials
General:					
Contractor's working drawings and design calculations have been approved, if applicable.					
Contractor has provided its proposed sources of materials.					
Backfill requirements have been discussed with the Contractor.					
Cast-in-Place Walls and Slopewalls:					
The Resident Engineer has approved the Contractor's proposed mix design.					
The Resident Engineer has inspected and certified the Contractor's proposed concrete plant.					
Portable plants have been properly permitted and inspected, as applicable.					
The Contractor's proposed sources of materials are acceptable.					
Precast Walls:					
Bridge Division has approved the precast wall system and shop drawings.					

Part 2: During Construction

Issue	Yes	No	N/A	Comments	Initials
General:					
Contractor is complying with OSHA excavation requirements.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Contractor provides adequate bracing when erecting wall systems.					
Contractor is using the correct type of backfill.					
Backfill is placed within the lines shown on the Plans.					
Foundation has been properly prepared.					
Proper architectural finish has been provided, if applicable.					
Wall drainage system is properly installed.					
Cast-in-Place Concrete Walls:					
Resident Engineer has approved the foundation.					
Walls have sufficiently cured prior to backfill placement.					
MSE Walls:					
Contractor is using appropriate backfill (internal friction angle of 34 degrees, cohesion of 0; unit weight of at least 120 lbf/ft^3)					
If using steel reinforcement, Contractor has demonstrated backfill complies with resistivity, pH, chloride, and sulphide requirements.					
Manufacturer's representative is present during wall erection.					
At the end of each work day, last level of backfill is sloped away from the wall to direct runoff.					
Panels meet the required tolerances.					
Slopewalls:					
Vertical construction joints are spaced less than 10 feet.					
There are no horizontal construction joints.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Type, number, and spacing of supports for reinforcing steel are adequate.					
Steel Sheet Piling:					
Minimum section modulus is as specified in the Plans or working drawings.					
Permanent piles are driven and cut off at the pile tip elevation shown in the Plans.					
Permanent piles are braced and painted in accordance with Contract requirements.					
Temporary piling is removed and disposed of when no longer needed.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Wall drainage system is functioning properly.					
Contractor adequately protects concrete walls from premature loading.					

SECTION 511 – REINFORCING STEEL FOR STRUCTURES

511.01 GENERAL

This work consists of providing and placing reinforcing steel.

511.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Proper handling and storage of reinforcing steel at the Project site. If storing epoxy coated reinforcing at the Project site for more than two months, it must be protected from the sun.
- Contractor's proposed source of materials, including mechanical splices if used.
- The importance of staggering lap splices and providing proper lap lengths.

B. Acceptance of Materials

Verify that the proposed source of fabrication and, when applicable, epoxy coating is on the Approved Product List (APL).

C. Preparatory Work and Contractor Work Plans

Before work involving reinforcing steel for structural concrete and concrete bridge decks begins, verify that the Contractor's Bar List conforms to the Contract with respect to bar size, quantity, and bending details. Discuss with the designer any discrepancies between the lists that may have been discovered by the Contractor or their fabricator.

D. Safety and Environmental Issues

None required.

511.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

Verify that the Contractor's source of fabrication and, when applicable, the epoxy coating facility are on the Approved Product List (APL).

The Project Inspector needs to compare the bar markings on non-epoxy coated reinforcing steel upon delivery with the photographs located on the Materials Division website to verify the reinforcing is from an approved mill and that it is of the correct grade and size. [Document in SiteManager Template AM5005]. If the reinforcing is not from an approved mill, obtain two 2-foot samples and contact the Materials Division for their action prior to proceeding with the use of this reinforcing steel.

Epoxy coated reinforcing steel is inspected by the Materials Division at the coating facility. The Project Inspector is to inspect the epoxy coated steel upon delivery for the following:

- Approved coater
- Tags and paperwork
- Coating has not been damaged during shipping or off loading

B. Equipment and Methods

Ensure that equipment for handling epoxy coated reinforcing steel has protected contact areas to prevent damage to epoxy coating.

C. Construction Operations

Verify the following during the storage and placement of reinforcing steel:

1. Handling and Storage

Monitor the Contractor's handling and storage operations to ensure that the necessary measures are being taken to protect steel from damage. This includes storing all reinforcing steel on platforms or skids to minimize contact with mud and lifting bars using a strong back, multiple supports, or a platform bridge.

For epoxy coated reinforcing, special treatment is required. Such measures include: supporting coated bars on pads, padding bundled bands, preventing bar-to-bar abrasion, avoiding dropping or dragging bundles, and using padded straps for lifting. Do not allow the Contractor to use chains for lifting purposes. If epoxy coated reinforcing is to be stored at the Project site for more than two months, it must be protected from the sun to prevent UV damage to the epoxy.

The storage conditions shown in Figure 511:1 are unacceptable. The reinforcing steel is in contact with the ground and appears to have been run over by equipment.

Figure 511:1. Photo. Unacceptable Storage of Epoxy Coated Steel

2. Bar Condition

Check reinforcing bars for mud, oil, excessive rust that results in loss of section, and heavy scale as concrete will only bond with a clean bar surface. Check bars for straightness or proper bend dimensions. The Contractor must avoid field bending of reinforcing bars because excessive bending will cause damage to the bar and may result in failure. To prevent this condition, encourage the use of mechanical splices. Ensure that all nicks, scratches and damage to epoxy coating is adequately repaired using epoxy patch material provided by the manufacturer and in accordance with Section 511.04.A(2) of the Standard Specifications.

3. Bar Size, Alignment and Spacing

Check that bar size, alignment and spacing conforms to the dimensions shown on the Plans and Standards. Verify that all bars and other embedded items are correctly placed so that the concrete can be adequately consolidated. Measure the spacing of parallel bars from center to center, and for circular cages, measure around the curve. When incorrect alignment and spacing is discovered, direct the Contractor to take corrective action.

4. Bar Clearance

Inadequate bar clearance, which causes insufficient concrete cover, is the leading cause of early concrete failure, and must be avoided at all costs. Check bar clearance and depth of concrete cover for compliance. Ensure that the proper minimum clearance is obtained between the top mat of deck bars and the surface of the concrete. For concrete clearance, measure the distance from the concrete face to reinforcing steel. Two inches of clear cover, measured perpendicular to the nearest concrete surface, must be provided for reinforcement unless otherwise specified in the Plans or Standards. For structural elements in direct contact with the ground, such as footings, abutments, retaining walls, and piers, 3 inches of clear cover must be provided.

5. Bar Splicing

Insufficient bar splicing or lap lengths will result in a weakened area of the concrete causing a failure plane. Check bar splices to ensure that they are the proper length for the type and size of bar placed. Verify that lap lengths are as shown on the Plans. If lap lengths are not shown, contact Bridge Division for the length required in accordance with the AASHTO LRFD Bridge Design Specification. Note that epoxy-coated bars require longer splices than uncoated bars. Verify that bar splices are correctly staggered.

If shown on the Plans, ensure mechanical couplers are of the size and type specified, and are installed in accordance with the manufacturer’s recommendations. The Resident Engineer may require testing of two of every one hundred coupler splices provided to verify their capacity.

For welded wire fabric shipped in rolls, the fabric must be flattened before placement. Sheets of mesh or bar mat reinforcement are to be spliced by overlapping at least one mesh width plus 2 inches. Ends and edges are to be securely spliced.

6. Bar Supports

Reinforcing steel must be properly supported to ensure adequate concrete coverage and that the reinforcing is at the proper location within the concrete. The type, number, and spacing of supports must be adequate to prevent sagging, displacement, and damage of reinforcing bars. Plastic-coated or epoxy-coated supports are required for epoxy-coated bars. Plastic bar supports are not allowed.

Reinforcing steel must be supported with mortar blocks, wire bar supports, supplementary bars, or other approved devices. Slab bar supports must be spaced no more than 4 feet, transversely or longitudinally.

When mortar blocks are used, they must be the same color and texture as the poured concrete encasing the mortar block. The mortar blocks must have a compressive strength that is equal to or greater than that of the poured concrete encasing the mortar block. For blocks in contact with the forms, the face of the blocks must be no bigger than 2 inches by 2 inches. Concrete block supports must be connected to the bar with 14 gauge wire cast in the center of each block. Plastic-coated or epoxy-coated wire must be used to support epoxy-coated reinforcing.

7. Securing of Bars

To minimize displacement, bars must be securely tied. Verify that the bars are tied at all intersections or as otherwise designated. Do not permit welding of bars except as noted on the Plans. Note that the use of coated ties is required for epoxy-coated bars.

For mats and cages, reinforcing bars must be tied at all intersections. If spacing is less than 12 inches in both directions, tying at alternate intersections is allowable. All intersections around the perimeter of a mat must be tied. All intersections of the last stirrup, hoop, or complete turn of a spiral must be tied at both ends of a cage.

Bundle bars must be tied together at intervals no greater than 6 feet. Bars may only be bundled if the location and splice details are required on the Plans.

D. Safety and Environmental Considerations

Plastic or rubber protectors must be placed on top of the exposed end of vertical reinforcing and must be removed before concrete placement.

Ensure that the Contractor exercises care when working on reinforcing steel mats or cages, especially epoxy coated reinforcing, to prevent slipping.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location or Structure Number and the type of work being performed.
- If a pre-pour inspection occurred and who was in attendance and any corrective actions identified.
- Any conditions requiring corrective actions, location of correction as well as individual contacted and their recommendations.

2. Measurement and Payment

When this item is Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the

SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Work Items tab or in the change order (i.e. description, explanation, attachment, etc.).

Documentation of this item will be performed within the SiteManager / Daily Work Reports / Work Items tab.

a. Select the appropriate pay item from the list of contract pay items.

b. In the appropriate field, enter the descriptive location (i.e. Structure #10 – Floor) or the station and location.

c. In the Placed Quantity field enter the pounds of reinforcing steel placed. This quantity will either be as shown on the plans or as shown on the supplier's bar list, if the reinforcing steel pay item is not specified as Pay Plan Quantity.

In the SiteManager / Daily Work Reports / Work Items tab / Remarks Bubble, provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown.

511.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

The Contractor must provide a Buy America certification in accordance with Section 106.01(b) of the Standard Specifications and provide documentation for any foreign steel incorporated into the Project.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated (i.e. summary of invoices, spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantities paid equals the plan quantity.

C. Protection of the Work

Splice steel extending out of previously placed concrete must be protected during phased construction to prevent damage from equipment or bending.

If the reinforcing steel is damaged, rusted or becomes coated with foreign material (mud, oil, etc.) after placement, it must be cleaned or replaced.

If epoxy coated reinforcing is in place for more than two months, it must be protected from the sun to prevent UV damage to the epoxy.

CHECKLIST – REINFORCING STEEL FOR STRUCTURES

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
All shipments are checked for condition, inspection tags, and approval.					
A check is made against bar lists, working drawings, and contract plans for size, number of bars, bends, and positions.					
Bars are kept in bundles, with tags attached, and stored under proper conditions.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Bars with thick or loose rust or scale, oil, grease, paint, curing compound, mud, or cement mortar are cleaned before use.					
Epoxy coated bars are checked and touchup is applied where needed.					
All bars are checked for size and position as they are placed in the forms.					
Ties and spacer blocks are checked, and bars at all splices are overlapped as specified and tied properly.					
Where concrete is placed in a unit or section and bars are left projecting into a section to be constructed later, the bars are in proper position.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Clearance to the steel from the forms meets the Specifications.					
Projecting bars are cleaned and protected against jarring that would destroy the bond in the concrete already placed.					

SECTION 512 – PAINTING

512.01 GENERAL

This work consists of preparing surfaces, applying and curing paint, and protecting the work facilities, vehicles, public, and environment from damage.

512.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- General items:
  - This work is highly regulated and care should be taken to comply with all CFR and ODEQ requirements
  - Source of materials
  - Surface preparation
  - Contractor's qualification
- Painting new structural steel:
  - Whether or not primer will be shop applied
  - Source of paint system
- Repainting existing structural steel:
  - The Contractor's plan for air monitoring and soil sampling
  - Blood tests requirements for Contractor's personnel
  - Level of surface preparation or overcoat system
  - Method for collection and disposal of hazardous waste

B. Acceptance of Materials

Ensure that proposed paint system is suited for the category of work shown on the plans and is in conformance with Table 512:1 of this Manual. Verify that the paint system (not the individual paint) is an approved system shown on the Approved Products List (APL).

C. Preparatory Work and Contractor Work Plans

The specifications do not require a work plan if the Contract requires painting a total area less than 500 square feet, but regulatory agencies (ODEQ, EPA, etc.) may require written plans and programs from the Contractor. At least 14 calendar days before beginning surface preparation, the Contractor must submit its written work plan to the Resident Engineer for review and acceptance. The plan should detail the methods of conducting and inspecting the work, and of protecting the environment, public, adjacent property, and workers. The work plan may be required by other state and federal agencies and should include the following:

- Material Safety Data Sheet (MSDS) and Product Data Sheet (PDS)
- Paint Removal and Painting Plan
- Chemical Strippers (Obtain authorization from the Bridge Division before allowing the use of chemical strippers)
- Quality Control (QC) Procedures
- Containment Design
- Waste Management Plan
- Waste Disposal Documentation
- Worker Protection Plan
- Environmental Compliance Plan
- Laboratory Services
- Certification (Contractor must certify that methods of waste management, storage and/or treatment and disposal are legal and conform to federal, state, and local regulations, and the Contract)
- Documentation (Contractor must maintain logs for samples collected, waste types and quantities generated, airborne emissions monitored, and batch numbers of coatings used)
- Reporting
- Painting Structural Steel
- Schedule

Additional details for these components of the work plan may be found in Section 512.04.A(2)(a) of the Standard Specifications and the Society for Protective Coatings (SSPC) Guide 6 specifications, which may be obtained from the Bridge Division.

Department acceptance of the work plan does not relieve the Contractor from the responsibility for addressing health, safety and environmental concerns. The Contractor must conduct the work in accordance with federal, state, or city regulations, and protect the health and safety of workers and the public.

D. Safety and Environmental Issues

The Contractor must submit a sampling plan and collect pre-job and post-job soil samples for lead content to verify that its activities have not contaminated the soil. The samples will be collected in the Resident Engineer's presence, and the Contractor will provide the Resident Engineer with splits of the samples and a chain of custody form. The Contractor will provide the test results from an ODEQ certified private lab within two weeks of collecting the samples. The Resident Engineer will keep these split samples until the Project is complete and the Department is satisfied that the Contractor's test results are acceptable.

The Contractor will use a certified lab to test blood, and submit the lab name and location to the Resident Engineer. Do not ask the Contractor for blood test results; they will be reported to the Oklahoma State Department of Health, Lead Poisoning Prevention Program.

Inspection personnel should not enter the containment area without proper training and safety equipment. As a minimum, inspection personnel must have successfully completed SSPC C.3 "Supervisor/Competent Person Training for Deleading of Industrial Structures". The Inspector must also comply with all requirements of Section 512.04.A(3)(a)3) of the Standard Specifications.

512.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

Ensure that the proposed paint system (not the individual paint) is an approved system shown on the Approved Products List (APL) [Document in Template AM5001].

After application of each coat of paint measure the dry coating thickness in accordance with SSPC-PA2, and ensure that the dry film thickness of each coat and total thickness of the finished product is in accordance with Table 512:6 of the standard specifications. If the dry coating thickness does not meet the specification requirements, the area must be cleaned and repainted. The results of these tests must be documented in the appropriate test template in SiteManager [add link] [Document in Template XXX]. The number of tests necessary to satisfy the sampling and testing requirements depends on the total square feet of surface area to be painted. The estimated surface area is indicated in the plans and must be entered into this calculating HTML [add link].

B. Equipment and Methods

1. Construction

The Contractor must provide adequate surface preparation and coating application equipment. Mixing equipment must be included for paint system components and pot agitation for zinc-rich coatings in accordance with the manufacturer's specifications.

The Contractor must provide compressed air for abrasive blast cleaning, conventional spray application, or blowing down surfaces. Ensure compressed air used for abrasive blast cleaning, conventional spray application or blowing down surfaces does not contain oil, moisture, black spots, and wet spots when tested in accordance with ASTM D4285.

Encourage the use of recycled abrasive materials to reduce the quantity of waste material to be disposed of.

The containment and dust collection equipment must be adequate to reduce emissions to an acceptable level as verified by the air monitoring equipment, when required. The Contractor shall provide a negative pressure in the containment area which can be verified by the containment tarps being pulled inward, taking into account any wind affects.

2. Testing Equipment

The testing equipment required for adequate inspection of the work performed shall include the following items:

- Sling Psychrometer
- Surface and Ambient Temperature Thermometers
- Dry and Wet Film Thickness Gauges
- Micrometer w/X-Coarse Tape or a Digital Surface Profile Gauge
- SSPC Visual Standard For Blast Cleaning (SSPC SP1-SP13)
- Plastic Calibration Shims
- Illuminated Microscope
- US Weather Bureau Psychrometric Tables
- Chloride test kit (exclude the cotton swab method)

The testing equipment listed in the specification must always be available for use by the Inspector. If the equipment is not available or in good working order, replacement equipment should be brought to the Project before production work is affected. The tables and visual standards used must be legible.

Contractor provided air monitoring, except for Category ‘R’ projects, must be in compliance with the Total Suspended Particulate (TSP) Lead Monitoring procedure as described in SSPC Technology Update No. 7 (SSPC TU-7), which may be obtained from the Bridge Division.

3. Documentation Required for Projects with Paint Removal

The contractor must provide the following documentation when applicable to the work being performed. Refer to section 512 of the standard specifications and Construction Control Directive No. 060717 for additional details on the documentation required.

- Approved Waste Disposal Plan (Large Quantity Generator, 2200 lbs of waste or more)
- List of Employees on project involved in Painting or Waste Removal (All employees usually)
- The name and location of the lab that performed the blood lead level testing for all employees involved in Painting or Waste Removal, and a copy of their Clinical Laboratory Improvement Amendments (CLIA) certification. The contractor must report blood lead levels to the Oklahoma State Department of Health, not the Resident Engineer.
- Soil Sample Reports (Before and After Cleaning) (All projects)
- Air Monitoring Reports (Projects within 300 Ft of occupied building)
- Waste Analysis Reports (Waste on all projects are to be treated as hazardous waste)
- Completed Form RCRA Subtitle C Site Identification Report (All projects)
- EPA Quarterly Report (Large Quantity Generator, 2200 lbs of waste or more)
- Completed Form GM (Large Quantity Generator, 2200 lbs of waste or more)
- Waste Shipping Manifest with ALL SIGNATURES (All projects)
- Certificate of Destruction (All projects)
- Closeout letter to ODEQ (Large Quantity Generator, 2200 lbs of waste or more)

C. Construction Operations

1. General

To protect structural steel from corroding, it is necessary to apply a protective coating system. The Contractor must use paint systems in accordance with Section 730 of the Standard Specifications appropriate for the application, categorized as follows:

Table 512:1
Paint System Application

Category	Application	Paint System
N	New structure. Shop-applied primer. Field-applied intermediate and topcoats.	IZ-E-U
E	Existing structure with all existing paint removed. Field-applied coats.	IZ-E-U, OZ-E-U [a] or SC-MC-U
O	Existing structure with existing sound paint (Overcoating). Field-applied coats.	SC-MC-U
R	Repair of existing structure. Field-applied coats. Application area limited to repair area as required by the Contract.	SC-MC-U or an approved Performance Class 2 paint system

[a] The Department will evaluate systems on a case-by-case basis pending acceptance.

The coating system consists of three coats, except for Category 'R' paint system. On new steel, an IZ-E-U paint system is required, and normally the inorganic zinc primer is applied in the fabrication shop and the remaining two coats are applied in the field. On existing steel all three coats are applied in the field, and alternate paint systems are available for use.

2. Quality Control (QC)

When applying coating systems, it is very important for the Contractor to constantly monitor the quality of the work. The Contractor is required to submit a Quality Control Plan (QCP), as part of its work plan, at least 14 days prior to beginning work for acceptance by the Resident Engineer. The QCP must include the following:

- Qualifications of personnel responsible for QC
- Written QC procedures for surface preparation and paint application
- Copies of documentation forms used for QC

The person responsible for the QC has many duties and responsibilities; therefore, formal training is required. NACE and SSPC provide QC training and certification in this area; contact Bridge Division for additional details. The Contractor should assign one person the duties of a Quality Control Specialist (QCS). If there is no QCS on the Project, the Contractor is not allowed to proceed with any production work.

The QCS must be properly equipped with all the necessary testing equipment, be able to climb to all parts of the structural steel, have the authority to stop the Contractor's work if necessary, and inform the foreman of all work that does not meet the requirement of the specifications.

Ensure that the Contractor complies with the written QC procedures for surface preparation and paint application outlined in the work plan. The proper documentation forms must be completed by the QCS and submitted to the

Resident Engineer in a timely manner and before the final payment is made for the painting.

3. Weather Limitations

Final abrasive blasting must be performed when the steel is at least 5 degrees F above the dew point. This is due to the possibility of condensation. The Contractor will be required to reblast the steel if this requirement is not met.

Paint must be applied when the temperature of the air within the enclosure, steel surface, and paint is from 40 to 100 degrees F. At higher temperatures the paint may “flash” dry and will not properly adhere to the surface. At lower temperatures the paint will not cure and in some cases the paint may not resume curing when the temperatures warm up. It becomes important to pay closer attention to the temperature in the early spring and the late fall, as the temperatures will be above 40 degrees F during the day, but the temperature will drop during the early evening hours before the paint has had enough time to properly cure.

The surface temperature of the steel should be taken in the areas of most extreme temperature. This is not always the same on every structure (e.g., the fascia beam bottom flange). You may be able to tell where to take your temperature reading by running your hand over the steel, or it may be necessary to take readings in multiple areas.

Paint must be applied when the temperature of the steel is at least 5 degrees F above the dew point. Applying paint to steel at temperatures below 5 degrees F above the dew point could result in condensation on the surface of the steel. The dew point is to be determined by using the psychrometer and the psychrometric tables. The psychrometer should be used in the area to be painted or blasted (i.e. in containment up near the beams). Note, if the barometric pressure is unknown when using the psychrometric tables, it is acceptable to assume a barometric pressure equal to 30 inches.

Heated enclosures may be used to maintain the temperatures above the minimum specified temperatures. If combustion type heating units are used, the exhaust fumes must not be permitted in the enclosure, but must be vented away from the enclosure. If exhaust fumes are not properly vented, they can leave a deposit on the surface that could affect the ability of remaining coats of paint to properly bond to the steel or the previous coats of paint. These exhaust deposits could also contaminate the freshly applied paint.

Paint must be applied when the relative humidity is 85% or less. For moisture cure paints (SC-MC-U), a humidity of at least 50% or as specified by the paint manufacturer in writing is necessary. Ensure that there are no predictions of rain, fog, or ambient air temperature below 40 degrees F during the drying period.

4. Inspection Access

Inspection personnel should not enter the containment area without proper training and safety equipment. Proper inspection cannot be accomplished unless the Inspector has access to every surface to be painted. In accordance with Section 105.11 of the Standard Specifications, the Contractor must allow Department personnel access to the work and provide any information and assistance required to make a complete and detailed inspection and documentation of the materials and the work. To accomplish this, the Contractor is required to provide, erect, and move scaffolding and all other equipment necessary to provide the Inspector access to closely inspect the work. All scaffolding must meet the requirements of 29 CFR 1910.28

On bridges with tall girders, placing scaffolding only under the girders is not adequate to provide proper access to the work. Do not climb around on the structural steel to inspect the work.

The Resident Engineer should never allow or instruct an inspector to use a means of inspection access that is not considered to be safe.

If the Contractor fails to provide proper access to inspect the work, he should not be allowed to continue work since proper inspection cannot be performed.

5. Surface Preparation

One of the most important items of work is surface preparation. It is also the most labor intensive and expensive phase of the work.

Before surface preparation begins ensure the following when applicable:

a. Pre-job soil samples have been taken by the Contractor and split with the Resident Engineer.

b. That the contractor's personnel have been tested by a Certified Industrial Hygienist (CIH) in a certified laboratory. The contractor must submit to the Resident Engineer the name and location of the lab, and a copy of their Clinical Laboratory Improvement Amendments (CLIA) certification. The contractor must report blood lead levels to the Oklahoma State Department of Health, not the Resident Engineer.

c. Air monitoring equipment is in place and operational in accordance with Table 512:4 of the Standard Specifications

d. Containment and dust collection equipment are in place and operational in accordance with Table 512:2 of the Standard Specifications.

Carefully monitor areas that have deterioration or rust, as abrasive blasting can remove entire sections of severely rusted steel members. If significant section loss of any structural steel element is observed, report this to the Bridge Division immediately. Failure to identify and correct deteriorated areas could result in failure of the structural element. Significant section loss is considered to be more than 15% of the original thickness of the structural element, and may be characterized by holes in the webs, thinning of the flanges, egg-shaped roller bearings, buckled webs, etc. Figure 512:1 shows significant section loss caused by abrasive blasting.

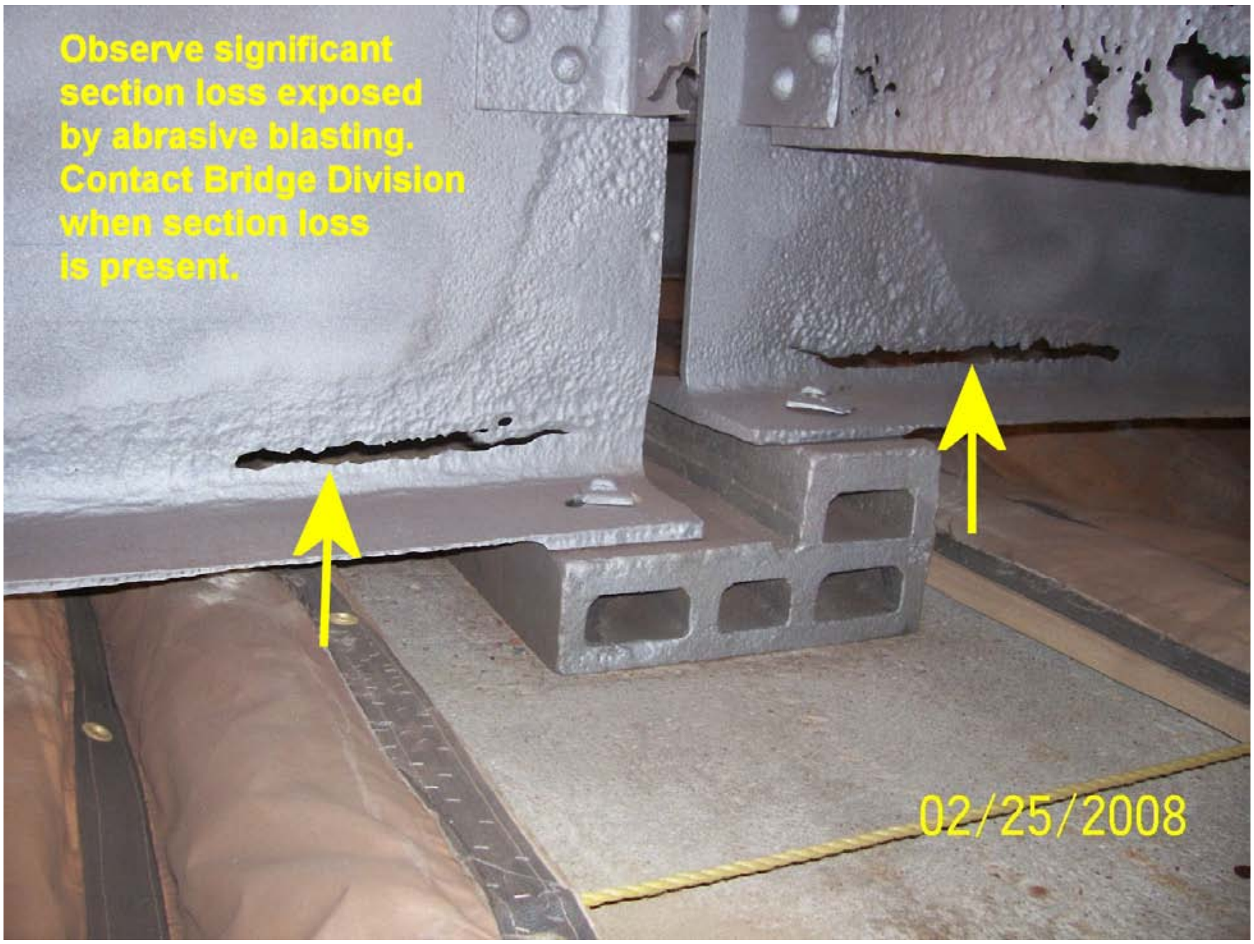


Figure 512:1. Photo. Section Loss caused by Abrasive Blasting

(a) New Steel or Existing Steel Stripped of Paint (Category N or E Paint Projects)

The Contractor must install covers to protect surfaces beneath the work area from cleaning agents and coatings. Do not allow the Contractor to begin cleaning operations until protective covers are in place. If the cleaning agents or water leaves the protected cleaning area, stop the cleaning operations immediately until containment is restored.

(1) Solvent Cleaning

Prior to abrasive blasting, areas that contain asphalt cement, oil, grease, or diesel fuel deposits must be solvent cleaned. It is not necessary for the Contractor to solvent clean the entire surface of the steel to be coated, but only those areas (e.g., beam ends, areas beneath joints, bearing assemblies, etc.) that are contaminated.

Solvent cleaning per SSPC-SP1 requires the removal of foreign material (other grease and oil) prior to solvent cleaning. This can be done by one or a combination of the following: wire brushes, abrading, scraping, or cleaning with solutions of appropriate cleaners followed by a fresh water rinse.

Make sure that all solvents brought on site are accompanied by a current MSDS for that product.

All solvent cleaning should be completed prior to the start of the abrasive blasting operation. If this is not accomplished, the abrasive blasting operation will not remove the asphalt cement, oil, grease, or diesel fuel deposits but drive them into the steel.

To remove all residual solvent, asphalt cement, oil, grease, or diesel fuel deposits after the solvent cleaning, all solvent-cleaned areas are to be washed with water at a pressure of at least 1,000 psi. In order to be effective, the nozzle must be held no further than 12 inches from the surface being washed.

(2) Abrasive Blasting Method

The containment and dust collection equipment must be adequate to reduce emissions to an acceptable level as verified by the air monitoring equipment. The Contractor is to provide a negative pressure in the containment area, which can be verified by the containment tarps being pulled inward, taking into account any wind affects.

The prime coat contains zinc that protects the steel by reacting chemically with the surface of the steel. Therefore, it is important to remove all foreign material from the surface of the steel to allow the zinc particles to come in contact with the bare steel. It is also important to roughen up or produce a profile on the surface of the steel. The profile aids the coating in adhering to the surface of the steel.

Steel surfaces to be painted are to be abrasively blasted to a near white metal, SSPC-SP10. SSPC-SP10 is generically defined as white metal with an allowable 5% staining. This allowable staining is a discoloration. It does not have any noticeable thickness. It should be looked at in 9 square inch areas as this is how the 5% staining is defined. It should be noted that SSPC-

SP10 does not allow magnification for this determination. During inspection, pay special attention to areas that are more difficult to blast or areas that might be difficult to inspect. These areas include under cross frames, around bolt heads and nuts, end dams, cross frames next to or close to back walls, and any other areas of limited access. After the steel is blasted, it must be maintained in that condition until it is painted.

When the area of an existing bridge to be painted is 50,000 square feet or less, verify the use of abrasives is in accordance with the requirements of SSPC-AB 1, 2 or 3. When the area of an existing bridge to be painted exceeds 50,000 square feet, the abrasive used in the field must be steel grit in accordance with the requirements of SSPC-AB 2. Generally speaking, AB 1 is non-steel blasting such as sand (quartz, garnet, etc.) blasting, and the use of silica sand should be avoided for health concerns. AB 2 is recycled steel blasting which minimizes the volume of waste material to be placed into landfills. AB 2 and 3 use steel shot and grit. Ensure the removal of all remaining dirt, mill scale, rust, paint, and other foreign material from exposed surfaces is performed in accordance with SSPC-SP 10, "Near-White Blast Cleaning." Verify the cleaning by comparing the cleaned surface to the visual picture in SSPC-VIS 1. Final abrasive blast-cleaning must be conducted when the steel surface temperature is at least 5 degrees F above the dew point.

If vacuum blasters are utilized, verify the use of aluminum oxide grit to achieve the required profile in accordance with Section 512.03.C.5(a)(5) of this Manual.

Some abrasives, when received by the Contractor, can be contaminated with oil. It can also get contaminated at the jobsite or during the blasting and recycling process. Therefore the abrasives should be checked to ensure that they are free of oil. This check should be made by placing a small amount of abrasives in a jar with tap water. The abrasives and water should then be stirred or shook up. The top of the water should then be checked for signs of oil. If oil is detected, the abrasives should not be used. This is done at the beginning of each shift and every four hours. If any oil is present in the water, the blasting operation must be suspended until the problem is corrected. After the operation is corrected, and before the blasting operation is permitted to proceed, another test should be made to ensure that the problem has been corrected.

Occasionally the compressed air used to propel the abrasive can become contaminated with oil or water from the compressor. This oil or water, if deposited on the surface of the steel to be painted, can be detrimental to the coating system. To prevent this problem, the quality control specialist must blow air from a nozzle for 30 seconds onto a white cloth or blotter held in a rigid frame. This testing must be done at the start of each shift, and at 4-hour intervals. If any oil, water, or other contaminates are present on the cloth or blotter, the blasting operation must be suspended until the problem is corrected. After the operation is corrected, and before the blasting operation is permitted to proceed, another test should be made to ensure that the problem has been corrected.

After abrasive blasting is completed, all abrasive and dust must be removed from the surface to be painted. Dust and abrasive must also be removed from any adjacent painted surface that also includes any adjacent structure. Dust and abrasive should be removed as soon as possible to prevent rust staining of adjacent surfaces. Rust stains can be very difficult to remove.

Care should be taken to monitor areas that have deterioration or rust, and report significant section loss of structural steel elements, such as that shown in Figure 512:1, to the Bridge Division.

(3) Wet Abrasive Blast-Cleaning Method

The advantage of using the wet abrasive blast cleaning method is the elimination of dust. However, the Contractor must comply with all environmental regulations including collecting and filtering the water. If the Contractor requests the use of the wet abrasive blast cleaning method, written approval must be obtained from the Bridge Division and the coating manufacturer prior to beginning blasting. Bridge Division will approve the blast cleaning procedure including methods to prevent light flash rusting before coating. The coating manufacturer will approve the compatibility of this surface preparation method with their coating system. Use SSPC-VIS 5/NACE VIS 9 to determine if the surfaces are Near White (e.g. C WAB-10).

Care should be taken to monitor areas that have deterioration or rust, and report significant section loss of structural steel elements, such as that shown in Figure 512:1, to the Bridge Division.

(4) Chloride Testing

After the Contractor does abrasive blast-cleaning, test potentially corroding areas, such as beam ends, for chlorides. Provide test kits called CHLOR*TEST, as manufactured by CHLOR*RID International Inc. of Chandler, Arizona or equal. An "equal" test kit shall meet the following requirements:

a. Kit contains all material, supplies, tools and instructions for field testing and on-site quantitative evaluation;

b. Kit extract solution is acidic, factory pre-measured, pre-packaged, and of uniform concentration;

c. Kit components and solutions are mercury free and environmentally friendly;

d. Kit contains a factory sealed titration device;

e. Kit contains new material and solutions for each test;

f. Test container (vessel, sleeve, cell. etc) creates a sealed encapsulated environment during chloride ion extraction;

g. Test container is suitable for testing the following steel surfaces: horizontal (up/down configuration), vertical, flat, curved, smooth, pitted, and rough;

h. Kit uses test container, with resulting chloride ion extract solution, as in the titration container; and

i. Chloride ion concentration is directly measured in micrograms per square centimeter without using either conversion charts or tables.

Do not use the cotton swab test method to test for chlorides. If the chloride content exceeds 7 $\mu g/cm^2$, ensure that cleaning continues until a chloride level less than 7 $\mu g/cm^2$ is attained before coating. The use of soluble salt cleaning aids or additives must be approved, in writing, by the coating system manufacturer prior to use. Ensure at least Class 3W containment to collect water, paint chips, and solids as specified in SSPC Guide 6. Consider waste hazardous until TCLP testing indicates otherwise.

(5) Anchor Profile Testing

Test the anchor profile height to ensure that it ranges from 1 mil to 3.5 mil, or at least the height that the coating manufacturer's product data sheet specifies. The profile should be continuously monitored during the blasting operation since the size of the abrasive can be reduced due to being recycled, which can in turn reduce the size of the profile. The size of the profile can also be reduced if the air pressure at the blasting nozzle is reduced. The profile should be monitored by the use of X-coarse replica tape and a spring micrometer, or by using a digital surface profile gauge. Both methods are in accordance with ASTM D 4417. Measure anchor profile height in at least four places for each 8 hour shift.

- Tape Method: Make sure the replica tape is X-coarse as this is the appropriate tape to measure our specified profile range of 1.0 mils to 3.5 mils. It is also necessary to account for the 2.0 mil adjustment required for the thickness of the replica tape. This adjustment can be subtracted from every reading or the micrometer can be zeroed to -2.0 mils which results in a direct reading being taken from the micrometer.
- Digital Method: A digital surface profile gauge consists of a dial gauge depth micrometer fitted with a pointed probe. Prior to use, the dial gauge must be zeroed by placing it on a piece of plate float glass. Hold the gauge by its base and press firmly against the glass. Adjust the instrument to zero.

Note: When there is a conflict between the two methods, the optical microscope method serves as a referee method for surface profile measurements.

Ensure the Contractor repeats blast cleaning until the specified profile is attained.

On the day of cleaning, the Contractor must remove dirt, dust, and debris from the surface by brushing, blowing with clean dry air, or vacuuming, and apply the first coat of paint. The blast-cleaning must be repeated if the surfaces rust or become contaminated before painting. On Category E projects, ensure that HEPA-vacuums are used to clean surfaces of lead paint residue or dust, except when inside containment with operating dust collectors. The Department will allow the use of oil-free compressed air to remove secondary dust not generated by the blasting operation.

(b) Existing Steel With Paint to Remain (Category O or R Paint Projects)

The Resident Engineer will determine the degree of surface corrosion present in accordance with SSPC-VIS 2. Depending upon the percentage of visible rust, surfaces must be cleaned and prepared in accordance with the following:

- SSPC-SP 1 – Solvent cleaning – all steel when asphalt cement, oil, grease, or diesel fuel deposits are present
- SSPC-SP 2 – Hand tool cleaning – 10% or less visible rust
- SSPC-SP 3 – Power tool cleaning – 10% or less visible rust
- SSPC-SP 10 – Near-white blast cleaning – more than 10% visible rust

- SSPC-SP 11 – Power tool cleaning to bare metal – more than 10% visible rust

Cleaning must extend at least 2 inches beyond damaged areas. Edges of the old paint must be feathered to make a smooth transition. If using hand or power tools, verify the cleaning by comparing the cleaned steel surface to the visual picture in SSPC-VIS 3.

Ensure that new structural steel used in repair applications is prepared for coating in accordance with SSPC-SP 10.

On the day of cleaning, the Contractor must remove dirt, dust, and debris from the surface by brushing, blowing with clean dry air, or vacuuming, and apply the first coat of paint. The cleaning must be repeated if the surfaces rust or become contaminated before painting. Ensure that HEPA-vacuums are used to clean surfaces of lead paint residue or dust, except when inside containment with operating dust collectors. The Department will allow the use of oil-free compressed air to remove secondary dust not generated by the cleaning operation.

6. Containment and Waste Disposal

The Contractor MUST comply with all Federal, State, and Local laws, rules, regulations and ordinances.

Due to the possibility of the existing coating containing lead, chromium, cadmium and barium, which are considered hazardous substances, the Contractor is required to erect an enclosure to completely surround the area where the existing coating will be removed. The enclosure must conform to the requirements of SSPC Guide 6 (see Table 512:2 in the Standard Specifications). A copy of SSPC Guide 6 may be obtained from the Bridge Division.

Not only must the enclosure be placed vertically around the sides of the blasting operation, it must also be placed on the ground under the blasting operation. In addition to containing potentially hazardous debris, the enclosure also prevents fugitive dust from escaping into the environment.

The enclosure must be constructed of materials that are free of tears, cuts, or holes to prevent dust from escaping into the environment. Holes, cuts, or tears that do occur must be repaired immediately and all work must be suspended until repairs are made. The perimeter of the enclosure must also extend up between the beams to the bottom of the concrete deck. All seams must be fastened or lapped in a manner that ensures a seal and does not allow any openings between the screens or materials of the enclosure. The area where workers enter and exit the enclosure must also be sealed.

In addition to placing an enclosure around the blasting operations, the Contractor must also place ground covers under all equipment. This ground cover must be placed under the equipment for its entire length, not just a portion of its length. If the ground is not properly covered, there is the possibility that it could become contaminated. These ground covers are also intended to reduce the impact of equipment leaking oil, fuel or hydraulic fluid.

Ensure all abrasive blasting debris, solvent cleaning debris (including rags, brushes, etc.), and water used for cleaning are collected and stored in separate, leak-proof, closed containers (drums, lined roll-off boxes, or both) for each liquid or solid waste (waste streams) in accordance with EPA requirements and state administrative code. For waste from dust collectors, add the label "From Dust Collectors." Ensure the containers are labeled in accordance with Section 512.04.A(3)(a)5) of the Standard Specifications.

To prevent vandalism, the Contractor must store waste containers on the Project site in a storage area secured by an 8 foot tall gated and locked chain link fence or an enclosed, locked storage container. Ensure the storage area meets the following requirements:

- Impenetrable tarpaulins are placed on the ground.
- Drums are placed on pallets no more than two deep or two high.
- Location is within the right-of-way. Storage areas outside the right-of-way or away from the Project site must have prior written approval from the Resident Engineer and Oklahoma DEQ
- Location is away from any flood plain and areas of ponded water.

Due to the possibility of the abrasives containing silver, selenium, mercury and arsenic in addition to the heavy metals contained in the existing coating, which are all considered hazardous substances, the Contractor is required to sample each waste stream at least four times during the course of the surface preparation operation. At least one sample must be obtained and tested by the Contractor prior to treatment or disposal. All samples are to be split with the Resident Engineer, and the Contractor must submit their split sample for testing. Each sample will be split three ways with the Resident Engineer retaining two of the splits for dispute resolution, if necessary. Once the test results have been obtained and determined to not require a dispute resolution, the Resident Engineer will return the split samples to the Contractor for treatment or disposal.

If the debris is deemed hazardous in accordance with Table 512:1 of the Standard Specifications, the Contractor must dispose of it within 80 days after it is generated. The 80 days starts as soon as the Contractor generates the debris, not after the completion of the abrasive blasting operation. If the debris remains on the Project site over 90 days, the State and the Contractor could be cited by the ODEQ. On smaller structures the debris can be removed in one operation. However, on larger structures where the abrasive blasting operation extends over a period of several months, it will be necessary to make several trips in order to comply with the 80-day limit. If after the 80 days, the Contractor has not properly disposed of the hazardous debris, all abrasive blasting and painting of the structural steel on the Project must immediately cease until the hazardous waste is properly disposed of. At this time, the Department must cease processing all pay estimates and send notification to the Contractor's surety that he has breached the contract.

7. Coating Application

(a) Inspection prior to Coating Application

Before coating application begins, ensure the following:

1. The specified paint has been provided.
2. The manufacturer's recommended shelf life has not been exceeded.
3. The paint is mixed in accordance with the manufacturer's instruction data sheet using mechanical mixers. Pot agitation is used for inorganic zinc and zinc-rich organic coatings. Verify continuous mixing during paint application.
4. Spray equipment is equipped with traps, filters, or separators to exclude oil and water from the compressed air
5. The Contractor verifies the compressed air cleanliness in accordance with ASTM D 5913.
6. No thinning occurs when using paints formulated ready for application.
7. Tarpaulins, screens, covers, or shields are installed to protect surroundings from paint.
8. The anchor profile and chloride test results comply with the specified requirements.
9. The surface to be painted has been cleaned and is free of dust, dirt, concrete splatters, etc. This applies to the intermediate and top coats as well as the primer.

(b) Inspection during Coating Application

During the Contractor's coating application, ensure the following:

1. Prime coat is applied within 12 hours of the completion of surface preparation.
2. Paint is applied with a spray, roller or brush, as specified by the manufacturer.

3. Paint is strained through a metal 30-60 mesh screen or a double layer of cheesecloth while pouring into the spray pot.

4. Any paint that lifts after the first application is scraped off, the cause is investigated and resolved, and the area is spot painted before the next application.

5. The paint remains agitated during application to prevent separation of pigment, zinc powder and other paint solids.

6. The paint film is free from build-up, runs, sags, skips, holidays, and thin areas. If encountered, suspend painting, have the Contractor repair these areas before the paint coat dries and do not allow painting to continue until the Contractor revises its methods to prevent further occurrence. Runs and sags are normally prevalent around bolts and areas of limited access. This is sometimes due to the fact the Contractor tries to paint these areas using a spray gun only (i.e. without the use of a brush). These defects must be corrected after each coat is applied. If not, the defect will just translate into the next coat and the repair will be more extensive. Holidays in the form of pinholes are difficult to detect. The best way to view pinholes is with the aid of a flashlight. The flashlight should be placed to shine a beam of light parallel to the painted surface. If pinholes are present in the top coat, they will appear as small white specs about the size of the end of a needle. If they are present in the intermediate coat, they will appear as small dark specs.

7. Immediately after painting, the Contractor uses an Engineer-approved wet film paint thickness gauge to verify the application rate of each coat adjusted for volatile content.

8. After each application measure the dry coating thickness in accordance with SSPC-PA2, and that the dry film thickness of each coat and total thickness of the finished product is in accordance with Table 512:6 of the standard specifications. The number of tests necessary to satisfy the sampling and testing requirements depends on the total square feet of surface are to be painted, and will be determined in accordance with SSPC-PA2 and ASTM D7091. For surfaces totaling up to 300 square feet, measure and record the thickness in each 100 square foot area. For surfaces totaling between 300 and 1,000 square feet, measure and

record the thickness in three random 100 square foot areas. For surfaces totaling greater than 1,000 square feet, measure and record the thickness in three random 100 square foot areas for the first 1000 square feet and in one additional 100 square foot area for each additional 1,000 square feet. If the dry coating thickness does not meet the specification requirements, the area must be cleaned and repainted. The results of these tests must be documented in the appropriate test template in SiteManager. If multiple coats of inorganic zinc are applied to achieve the required primer thickness, the contractor must test the adhesion of the overlying coats in accordance with ASTM D 4541, ensuring the adhesion strength is the larger of 500 psi or the paint manufacturer's recommended performance criteria for adhesion.

9. If mud-cracking occurs in areas with inorganic zinc primer, the Contractor must blast-clean back to soundly bonded primer, and recoat to the required thickness.

10. Each application of paint is cured in accordance with the manufacturer's published data before application of the next coat. Generally inorganic zinc primer is cured for 48 hours, at a humidity of at least 45 percent. Monitor the relative humidity using a sling psychrometer, and if the humidity is less than 45 percent ensure the Contractor applies a mist to the inorganic zinc primer to ensure proper curing.

11. Before applying the intermediate coat, the Contractor must test the cure of the inorganic zinc primer in accordance with ASTM D 4752, "Standard Test Method for Measuring MEK Resistance of Ethyl Silicate Zinc Rich Primers by Solvent Rub" and ensure that it provides a Resistance Rating of "5" (No effect on surface - no zinc on cloth after 50 double rubs).

12. Before applying additional coats, ensure previous coats are cured, dry, and free of dust, dirt, salt, and other deleterious materials.

13. Skips, holidays, thin areas, and deficiencies have been corrected before the next application.

14. Contrasting colors are used for succeeding applications of paint. Do not allow field-tinting.

15. When using a Category O paint system, bare steel is spot coated with primer to the Contract required thickness.

16. When using a Category E or O paint system, a brush applied stripe coat of 100% penetrating sealer is applied between the prime coat and the intermediate coat, in accordance with the manufacturer's recommendations. The sealer should be painted over corroded, rust-stained, or pack-rusted surfaces that abrasive blast-cleaning could not remove. Figure 512:2 provides an example of pack rust.

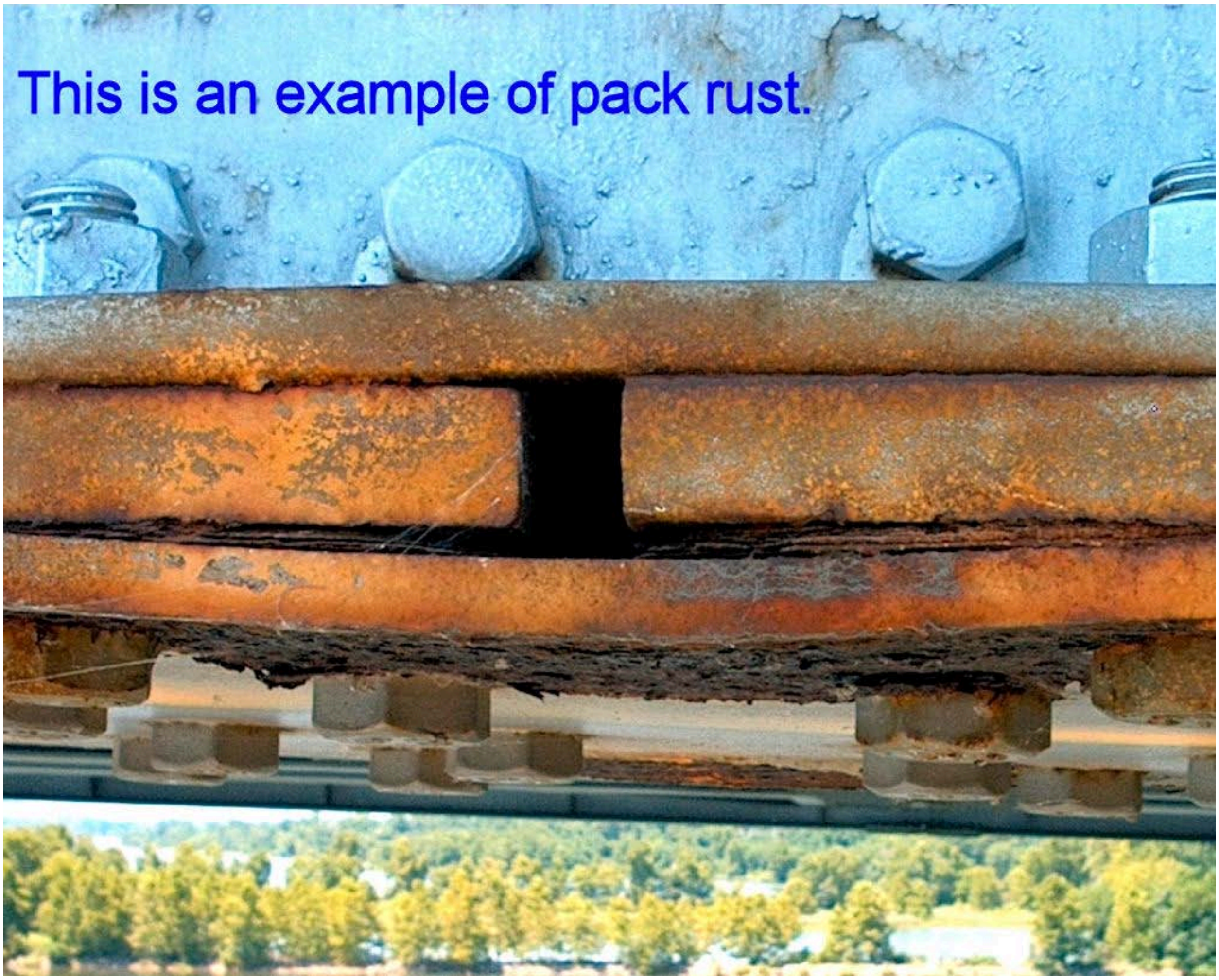


Figure 512:2. Photo. Pack Rust

17. Between the prime coat and the intermediate coat, a paintable caulking (paint will not adhere to pure silicone caulk) is applied at all locations shown on the Plans or required by the Resident Engineer including seams at joints, plates, and field splices where water may collect.

Do not allow the Contractor to place caulking over areas with pack rust. Use a product compatible with the coating system and as recommended by the coating manufacturer. Provide MSDS and PDS to the Resident Engineer and Materials Divisions.

18. Before the full intermediate coat is applied, a brush applied stripe coat of the intermediate coating is applied to all sharp edges, outside corners, and caulked seams and joints to ensure adequate coverage at these locations. The inorganic zinc primer has a tendency to pull away from edges resulting in insufficient thickness. The inorganic zinc primer will not adhere to itself, therefore additional thickness is achieved by applying this stripe coat of the intermediate coating.

19. The Contractor stencils the following information on the inside of the exterior girder on the southwest corner of the bridge:

    a. Bridge number (five digit NBI number)

    b. Paint type for each coat

    c. Paint manufacturer name

    d. Contractor name

    e. Date of completion

Generally, when painted replacement girders are specified, the prime coat is applied by the fabricator. Inspect the replacement girder for damage to the primer and ensure any necessary repairs are made before allowing the application of additional coats.

(c) Repair Procedures

If it is necessary to make repairs, the damaged painted surfaces must be repaired with materials and thicknesses equal to the damaged coat at no additional cost to the Department. The intent of the specifications is that the repair be made in a manner that the repaired areas will blend in with the surrounding area so that it is not evident that a repair was made.

If the area to be repaired does not cover a large area, abrasively blasting the surface may not be advisable due to the fact that it will damage the surrounding coating that does not need to be removed. Instead of using abrasives, the Resident Engineer may allow alternate methods of preparing the surface. This might include the use of power tools with abrasive bits or hand tools. However, whatever method is used, it is still necessary to prepare the surface in a manner that will give a surface profile of between 1.0 to 3.5 mils.

In order to produce a smooth transition, it is necessary to feather the adjacent coatings. The new coat of paint should only be applied to the same coat as was feathered (i.e. the prime coat should only be applied to the feathered prime coat, the intermediate coat should only be applied to the feathered intermediate coat, and the finish coat should only be applied to the feathered finish coat).

Since surface preparation is being performed and paint is being applied, all work limitation and documentation requirements are in effect.

Ensure that the paint thickness after repair does not exceed the maximum allowed for the Project.

D. Safety and Environmental Considerations

Ensure that all required air monitoring equipment is in place and operational in accordance with Table 512:4 of the Standard Specifications, and that containment and dust collection equipment are in place and operational in accordance with Table 512:2 of the Standard Specifications.

Once all the surface preparation and paint application work is completed, ensure that post-job soil samples have been taken by the Contractor and split with the Resident Engineer. The Contractor will provide the test results from a ODEQ certified private lab within two weeks of collecting the samples. The Resident Engineer will keep these split samples until the Project is complete and the Department is satisfied that the Contractor's test results are acceptable.

Once all the surface preparation and paint application work is completed, ensure that the Contractor's personnel are in compliance with all blood testing requirements (this does not mean that the Resident Engineer sees the blood test results, only confirm with the Contractor that the personnel on the Project are in compliance).

Ensure all abrasive blasting debris; used solvents, thinners and reducers; solvent cleaning debris (including rags, brushes, etc.); and water used for cleaning were collected, stored and transported in accordance with EPA requirements and state administrative code to a properly licensed disposal facility. If the debris is deemed hazardous in accordance with Table 512:1 of the Standard Specifications, the Contractor must dispose of it within 80 days after it is generated. The Contractor is to provide a copy of the shipping manifest EPA Form 8700-22 and, if necessary, EPA Form 8700-22A (continuation sheet). If the debris is deemed non-hazardous, the Contractor must provide a Non-Hazardous Waste Manifest to document quantity and disposal.

E. Documentation

1. Daily Work Report

Document the following information, as appropriate:

- Location and description of work being performed (i.e. Bridge 'A', Span # 1, Blast Cleaning, Caulking, Applying Stripe Coat, etc.)
- Conditions affecting the progress of or delaying prosecution of the work, equipment break downs, etc.
- Discussion of project prosecution with the Contractor that are of an unusual nature and any specific recommendations or instructions to the Contractor
- Weather Conditions during application and curing
- Any conditions requiring corrective actions, and individual contacted and their recommendations
- Document who performs the corrective actions

2. Measurement and Payment

Documentation of these Lump Sum items will be performed within the SiteManager / Daily Work Reports / Work Items tab.

- Select the appropriate pay item from the list of contract pay items.
- In the appropriate field, enter the descriptive location (i.e. Bridge 'A' – Span #1) or the station to station extents and location.
- In the Placed Quantity field, enter an estimated percentage of the lump sum item completed, ensuring that the total quantities to date does not exceed 1.00 Lump Sum.

In the SiteManager / Daily Work Reports / Work Items tab / Remarks Bubble, provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown.

The Resident Engineer should withhold a percentage of the total payment for these items (up to 20% for each item) until the contractor has provided the documentation referenced in section 512.03.B.3 of this Manual.

512.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

None required.

B. Audit Requirements

Ensure the project file contains the documentation referenced in section 512.03.B.3 of this Manual.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Payment for this item must equal 1.00 Lump Sum. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

The Contractor should curtail any other work in the vicinity that may adversely impact the paint systems during curing (e.g. dusty operations when paint is freshly applied).

Care should be taken around painted surfaces between coats and after coating is completed to prevent any damage to these surfaces.

CHECKLIST – PAINTING

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Proposed paint system is appropriate for the work required.					
Proposed paint system is on the APL.					
Contractor has provided a written work plan (needed for painting areas greater than 500 square feet).					
Contractor has submitted a written quality control plan addressing surface preparation and paint application.					
Contractor has collected pre-job soil samples for lead content.					
Contractor has provided adequate containment and dust collection equipment to reduce emissions.					
Contractor's personnel are in compliance with blood testing requirements.					
Contractor provides scaffolding to provide adequate access to inspectors.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Surface Preparation:					
Air monitoring equipment is in place.					
Containment and dust collection equipment are in place and operating as required.					
For surface preparation of new steel or existing steel stripped of paint (Category N or E paint projects), the Contractor solvent cleans contaminated areas prior to performing abrasive blasting.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Abrasives are free of oil.					
Final abrasive blasting it performed when the steel is at least 5 degrees F above the dew point.					
Steel surfaces to be painted are abrasively blasted to a near white metal, SSPC-SP10.					
Blast cleaning does not result in significant section loss.					
All dust and abrasive is removed as soon as possible after the completion of abrasive blasting operations.					
For existing steel with paint to remain (Category O or R paint projects), surfaces are cleaned and prepared in accordance with the degree of surface corrosion present.					
Abrasive blasting debris, solvent cleaning debris, and water used for cleaning are collected and contained in separate, leak-proof containers and stored in a secure area.					
Contractor disposes of hazardous waste within 80 days of generation.					
Coating Application:					
Contractor is applying the specified coating system.					
The surface to be painted has been cleaned and is free of dirt, dust, concrete splatters, etc.					
Prime coat is applied within 12 hours of the completion of surface preparation.					
Paint is applied when the temperature of the air within the enclosure, steel surface, and paint is from 40 to 100 degrees F.					
Paint is applied when the steel is at least 5 degrees F above the dew point.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Paint is applied when the relative humidity is 85% or less.					
No rain, fog, or ambient air temperature below 40 degrees F is predicted during the drying period.					
Paint remains agitated during application.					
Paint film is free from build-up, runs, sags, skips, holidays, and thin areas.					
Dry coating thickness meets specified requirements.					
Each application of paint is cured in accordance with the manufacturer's recommendations.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Contractor has collected post-job soil samples for lead content.					
Contractor's personnel are in compliance with blood testing requirements.					
Contractor provides waste manifests to demonstrate that abrasive blasting debris; used solvents, thinners and reducers; solvent cleaning debris; and water used for cleaning were transported and disposed of at a properly licensed disposal facility.					
Care is taken to prevent damage to painted surfaces between coats and after coating is completed.					

SECTION 513 – REPAIR OF CONCRETE BRIDGE DECKS

513.01 GENERAL

This work consists of patching decks, repairing decks, or both.

513.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Contractor's responsibility to submit a work plan in compliance with Section 513.04.B of the Standard Specifications
- Equipment requirements (e.g., jack hammers no larger than 15 pounds and operated at no more than 45 degree angle from above horizontal).
- Discuss source of materials and Concrete Mix Designs (Class AA, HDC, LMC, VES I, VES III, and RSLMC) in accordance with Section 701.01.C of the Standard Specifications
- Discuss source of galvanic anodes and any deviations from the requirements of Section 513.04.D of the Standard Specifications. All deviations must be approved by Bridge Division prior to installation of the anodes.
- No concrete will be placed until an inspection is held and the area to be patched is approved by the Resident Engineer

B. Acceptance of Materials

1. Concrete Mix Design

For structural concrete, the Contractor will submit its proposed concrete mix designs. The Resident Engineer will approve the concrete mix design in accordance with Section 701.01 or Section 701.20 of the Standard Specifications. As soon as practical, the Residency will obtain sufficient samples of aggregates to be used and perform applicable tests on these materials.

2. Concrete Plants

The Resident Engineer will inspect and certify the proposed concrete plant in accordance with Section 414.03.A of the Standard Specifications and will submit this information to the Materials Division.

3. Sources of Materials

The Contractor will submit its proposed sources of materials. The Residency will verify that the proposed sources of materials are on the Approved Products List (APL). If a proposed source is not on the APL, the Resident Engineer must contact Materials Division immediately. Verify the APL for the following:

- Structural Concrete – source for each individual component, in accordance with Section 509 of this Manual
- Reinforcing Steel
- Galvanic Anodes
- Curing Materials

C. Preparatory Work and Contractor Work Plans

At the pre-work meeting, the Contractor shall submit to the Resident Engineer for approval, a work plan in accordance with Section 513.04.B of the Standard Specifications that covers the following:

- Material:
    - What type of concrete to be used for patching
    - Source of concrete materials
    - Concrete to be mixed on or off site (ensure that delivery time does not exceed set time)
    - What type and source of anodes will be used
    - Source of replacement reinforcing steel, if required (to replace severely corroded or damaged reinforcing)
- Equipment:
    - Chain drag or sounding hammer
    - Pachometer
    - Saws (method to prevent cutting into reinforcing steel)
    - Jack hammers and chipping hammers (not to exceed 15 pounds)
    - Air compressors (oil free)
    - Concrete mixers
    - Vibrators
    - Finishers
    - Thermometers (surface and ambient)
- Procedures for removing and placing patches, including protection of traffic beneath the repair area
- Forms
- Labor requirements
- Anticipated work schedule including:

- ◦ Traffic control
- ◦ Project phasing
- ◦ Patching cure times (not always practical to cure 7 to 10 days – wet cure as long as possible)
- ◦ Surface preparation
- ◦ Estimated placement time

The Resident Engineer has 14 days to review and approve or reject this work plan.

D. Safety and Environmental Issues

Discuss with the Contractor its plan detailing how to protect workers and traffic during construction, including:

- Providing fall protection for workers,
- Preventing tools, material etc. from falling on traffic beneath,
- Providing traffic control during construction,
- Providing lighting equipment for night work,
- Providing skin and eye protection for workers, and
- Properly disposing of waste concrete or materials. Do not allow the Contractor to place concrete or other materials in streams or waterways.

513.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

1. Concrete Mix Design

Ensure that the Resident Engineer has approved the concrete mix design in accordance with Section 701.01 or Section 701.20 of the Standard Specifications. Any changes to the approved concrete mix design, including substitution of material sources, must be approved by the Resident Engineer.

2. Concrete Plants

Ensure that the concrete plant has been certified in accordance with Section 414.03.A of the Standard Specifications.

3. Sources of Materials

Ensure that the Contractor has submitted its proposed sources of materials. The Residency will verify that no changes were made from the proposed sources of materials and that they are still on the APL. If a proposed source is not on the APL, the Resident Engineer must contact Materials Division immediately.

Document or perform applicable tests as follows:

- Structural Concrete – sample and test for each individual component, in accordance with Section 509 of this Manual.
- Fibers - ensure that they are provided from an approved source, as shown in the APL [add link]. [Document in Template AM5001]
- Reinforcing Steel – accept in accordance with Section 511 of this Manual.
- Galvanic Anodes – ensure that they are provided from an approved source, as shown in the APL. [Document in Template AM5001]
- Curing Materials - ensure that they are provided from an approved source, as shown in the APL. [Document in Template AM5001]

B. Equipment and Methods

Ensure that the Contractor protects the deck from oil or other harmful material by providing equipment with traps, filters, drip-pans, or other devices.

The Contractor must use the following types of surface preparation equipment as required by the Contract and as directed by the Resident Engineer:

- Chain drag, sounding hammer or other approved method to locate unsound concrete and determine the limits of the patch.

- Pachometer for locating the existing reinforcing steel and estimating the amount of cover.

- Sawing equipment capable of cutting concrete to the required depth without damaging the existing reinforcing steel.

- Power-driven hand tools, jack hammers, and chipping hammers that weigh no more than a nominal 15 pounds. Jack hammers are to be operated at angles of 45 degrees or less from horizontal.

- Hand-held blast cleaning equipment for sand-blasting or water-blasting to expose the aggregates in the existing deck concrete. Water-blasting equipment must deliver at least 25 gpm at 4,000 psi.

- Proportioning and mixing equipment for concrete in accordance with Section 505.03.H of the Standard Specifications.

- Vibrating screed to finish the deck surface. On small patches where a vibrating screed is impractical, hand tools may be used to vibrate, strike-off, and leave a rough finish.

- Lighting equipment for night work in accordance with Section 509.4.C(3)(c) of the Standard Specifications.

C. Construction Operations

1. General

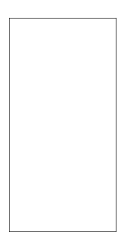
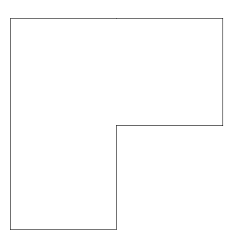
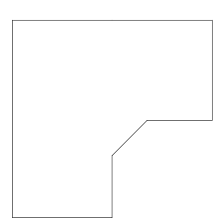
Ensure that the Contractor complies with the approved work plan, including protection of any traffic beneath the repair areas.

The Contractor must remove existing overlays, asphalt, unsound concrete, and foreign materials from the deck surface. The Contractor may use a chain drag, or any other method approved by the Resident Engineer, to locate delaminations in the bridge deck. Before removal, the Contractor must obtain the Resident Engineer's approval for the deck removal areas. Removal of unsound concrete must be performed using equipment in accordance with the approved work plan and Section 513.03 of the Standard Specifications.

2. Patch Preparation

Before sawing, the Contractor should locate and estimate depth of the existing reinforcing steel using a pachometer. The Contractor must provide a saw-cut vertical edge around the perimeter of the repair areas at least 1 inch deep, measured from the original deck surface, unless the existing reinforcing steel has less cover. Do not allow patches with re-entrant corners. See Figure 513:1 for acceptable and unacceptable patch geometries. Ensure the dimensions of a 45 degree re-entrant corner equal at least 4 inches. Inspect the removal areas to ensure that the Contractor has not cut, stretched, or damaged any exposed reinforcing steel. All exposed reinforcing steel must be blast cleaned. Any reinforcing steel exhibiting section loss in excess of 20 percent or damaged by the Contractor must be replaced or repaired, being certain that the new and the old reinforcing are lapped as required by the Resident Engineer.

Figure 513:1
Acceptability of Patch Geometry

Acceptable	Unacceptable	Acceptable
		

3. Anodes

Ensure that galvanic anodes are embedded at the perimeter of the patch to protect against corrosion. Pre-manufactured anodes must be used that contain a minimum of 100 grams of zinc metal, in accordance with ASTM B418-95a Type I. Ensure the anodes are tied to the uncoated reinforcing steel using the integral tie wires as follows:

(a) Installation

Verify the galvanic anodes are installed along the perimeter of the repair where reinforcing steel enters the interface between the existing concrete and the patch. Ensure that the spacing between the anodes is limited to a maximum of 24 inches and are only placed around the perimeter of the patch.

(b) Clearance

Verify that enough clearance is provided between the anodes and the surfaces of the repair area to allow repair material to encase the anode. On deck repairs the anode should be at least 1 inch below the finished surface.

(c) Attachment

Ensure the galvanic anodes are secured close to the patch edge using anode tie wires wrapped around the cleaned reinforcing steel. Tie wires should be twisted to prevent movement.

When conditions allow, the anode should be placed at the intersection between two bars and secured to each clean bar. If the anode must tie onto a single bar, or if using less than 1 inch of concrete cover, the anode should be placed beneath the bar and secured to clean reinforcing steel.

(d) Electrical Continuity

Verify that the exposed reinforcing steel is cleaned of foreign material, such as rust, mortar, etc. in order to provide an electrical connection and mechanical bond between the anode and the reinforcing steel.

Monitor the Contractor’s measurement of the electrical connection between the anode tie wire and the reinforcing steel using a multi-meter to determine the DC resistance (ohm).

Confirm electrical continuity of the exposed reinforcing steel within the repair area. If necessary, electrical continuity may be established with steel tie wire.

Ensure the electrical continuity in all areas tested is less than 1 ohm.

4. Cold Weather Placement

(a) Conditions requiring Cold Weather Practices

Ensure the Contractor implements cold weather practices if one or more of the following conditions occur:

- The air temperature was less than 55 degrees F within the past 24 hours of placement.
- The air temperature will be less than 55 degrees F within the next 6 hours of placement.
- The existing concrete surface temperature is less than 55 degrees F during placement.

(b) Cold Weather Practices

When placing concrete in cold weather, the Contractor should implement the following practices:

- Maintain a concrete mix temperature of at least 75 degrees F during placement.
- Complete placement during the warmest part of the day. (The Inspector should ensure rising air temperature during placement.)
- Place early strength concrete at air and deck temperatures greater than 45 degrees F.
- Protect the concrete during the curing period so that the surface temperature does not drop below 50 degrees F, in accordance with Section 509.04.B.4 of the Standard Specifications. The Contractor must provide and install recording thermometers, maturity meters, or other recording temperature measuring devices to verify that the concrete is protected. Extend the protection period to 10 days if fly ash, slag, and silica fume are used in the concrete.

5. Mixing

(a) Class AA and High Density Concrete

Ensure the concrete is mixed in accordance with Sections 414.03 and 414.04.B and C of the Standard Specifications.

(b) Latex Modified Concrete

Ensure the Contractor proportions and mixes latex modified concrete materials in accordance with the following:

(1) Measurement of Materials

Verify that the Contractor performs the following:

- Proportions materials for the concrete mixture with a mobile continuous mixer;
- Calibrates the proportioning equipment for each material in the presence of the Resident Engineer;
- Operates the proportioning equipment at the equipment manufacturer's recommended speed; and
- Checks and verifies yields of the mixture.

(2) Mixing of Materials

- The materials are mixed in accordance with the equipment manufacturer's recommendations.
- The mixture is uniform in composition and consistency.

6. Placement

During placement, ensure the Contractor performs the following:

- Cleans and dries the repair area before placing the patch;
- Places Type AA, VES I, VES III, or RSLMC in the prepared area in a continuous operation;
- Consolidates the repair concrete using a vibrating screed;
- For patch areas with a thickness of at least 3 inches, internally vibrates the fresh concrete;
- Provides a rough finished texture on repair areas for which the Contract requires an overlay;
- Where not placing an overlay, places concrete to the existing deck level and matches the surface texture of the repair with the existing deck;
- Proceeds with finishing operations steadily, completing the final finishing before a plastic surface film forms or before the initial set begins; and
- Covers the patch with insulating blankets that have an R value of at least 5 within 15 minutes of placement. The Contractor should weigh down the blanket edges continuously to prevent wind from blowing under the blanket. Insulating blankets should be maintained until the concrete reaches compressive strength or 24 hours, whichever is less. The Contractor should provide insulating blankets year round, including summer.

7. **Curing**

(a) **Overlay Substrate Patching**

Ensure the repairs are water cured in accordance with Section 509.04.F(3) of the Standard Specifications, for 7 days or until overlay placement. Do not allow the Contractor to use curing compound as this will act as a debonding agent for the overlay.

(b) **Surface Patching**

Ensure the repairs are water cured in accordance with Section 509.04.F(3) of the Standard Specifications, for 7 days. Additionally, cure all repair classes in accordance with Section 509.04.F(4) of the Standard Specifications immediately following the water cure period. If the deck surface must be opened to traffic in less than 7 days, water cure patches in accordance with the following:

- Class AA concrete for at least 24 hours
- VES I, VES III, and RSLMC, until the patch reaches the strength required by the Contract

8. Straightedge Testing and Surface Tolerance

Ensure the Contractor performs straightedge testing in accordance with Section 414.04.I(5) of the Standard Specifications. This entails using a 10-foot straightedge to test the smoothness of the concrete surface. After floating and removing excess water, and while the concrete is still plastic, the Contractor will lay the straightedge on the repaired deck parallel to the centerline to ensure that the surface does not vary more than ⅛ inch from the lower edge of the straightedge. The transverse slope of the patch must not have depressions greater than ⅛ inch when tested with the 10 foot straightedge extending from edge to edge in a traffic lane transverse to the centerline. After curing, the surface must be retested, and areas higher than ⅛ inch deviation must be ground. The ground surfaces must be grooved to have a texture equal to the surrounding surfaces.

9. **Deck Patch Classification**

(a) **Class A Bridge Deck Repair**

The Contractor's Class A bridge deck repair work should consist of the following:

- Removing unsound concrete to the top mat of reinforcing steel by chipping with power hand tools in accordance with Section 513.03 of the Standard Specifications;

- Disposing of removed concrete;

- Replacing the removed concrete with high density concrete, latex modified concrete, VES I concrete, VES III concrete, or RSLMC; and

- Notifying the Resident Engineer before removing concrete below the top mat of reinforcing steel.

(b) Class B Bridge Deck Repair

The Contractor's Class B bridge deck repair work should consist of the following:

- Removing unsound concrete below the top mat of reinforcing steel but above the bottom mat of reinforcing steel by chipping with hand tools in accordance with Section 513.03 of the Standard Specifications

- Cleaning concrete off the top reinforcing steel mat in the repair area;

- Disposing of removed concrete;

- Replacing the removed concrete with high density concrete, latex modified concrete, VES I concrete, VES III concrete, or RSLMC; and

- Notifying the Resident Engineer before removing concrete below the mid-depth level. Concrete should be removed at least 1 inch below the top mat of reinforcing steel.

(c) Class C Bridge Deck Repair

When removal of the unsound concrete reaches the bottom mat of reinforcing steel, the Contractor should remove the full depth of the deck, leaving the reinforcing steel intact, and use Class C repairs.

The Contractor's Class C bridge deck repair work should consist of the following:

- Providing forms in accordance with Section 502 of the Standard Specifications to place new concrete in the full-depth opening. For areas of at least 1 square yard, forms can be supported from the existing superstructure. For smaller areas, wire tires should be used to suspend the forms from existing reinforcing bars. Forms must be removed after completion. The work plan submitted to the Resident Engineer must show typical forming details. The Resident Engineer may contact the Bridge Division for approval of forming details, especially in areas over traffic.

- Cleaning existing concrete from reinforcing steel mats in the repair area;

- Disposing of removed concrete; and

- Replacing the removed volume of concrete with Class AA concrete or Resident Engineer approved rapid setting concrete.

D. Safety and Environmental Considerations

Ensure the Contractor complies with its plan to protect workers and traffic during construction including:

- Providing fall protection for workers;
- Preventing tools, material etc. from falling on traffic beneath;
- Providing traffic control during construction;
- Providing lighting equipment for night work;
- Providing skin and eye protection for workers; and
- Properly disposing of waste concrete or materials. Do not allow the Contractor to place concrete or other materials in streams or waterways.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location or Structure Number and the type of work being performed.
- If a pre-pour inspection occurred and who was in attendance and list any corrective actions identified.
- Quantity and classification of concrete placed.
- Whether or not proper curing method is being performed and note any deficiencies observed and corrective actions taken. Document curing method and length of time cured.
- When the surface finishing is performed and the Class of surface finish applied.
- Any conditions requiring corrective actions, location of correction as well as individual contacted and their recommendations

2. Measurement and Payment

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

The Engineer will not measure Class A and Class B repairs necessitated by hydrodemolition for payment.

The Engineer will measure Saw-Cut Grooving in accordance with Subsection 506.05 of the standard specifications.

Documentation of these Square Yard items will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template.

a. Select the appropriate pay item from the list of contract pay items.

b. Open the ‘DWR Templates’ icon in the toolbar.

c. Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to be used as the method of documentation for the work performed.

d. Select the appropriate method of measurement from the Type radio button options. Depending on the option selected, enter the following information:

(1) Two Dimensional Measured Quantity Option.

This option can be used to allow the template to calculate areas for progressive payments or for documenting the final quantity. Typically this option will be used for areas involving simple calculations which will only require length and width.

a. In the appropriate fields, enter both a descriptive location and the station to station extents.

b. Input the measured length and width to calculate an area.

c. For additional areas or additional locations, with different dimensions, select the ‘New Row’ button.

(2) Calculated Quantity Option.

This option will allow the input of quantities calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), and can be used for progressive payments or for documenting the final quantity of areas. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

a. In the appropriate fields, enter both a descriptive location and the station to station extents.

b. In the Placed Quantity field, enter the calculated quantity (SY) of the item completed.

c. In the Book/Folder/Envelope # field provide the location of the documentation for the calculations.

d. For additional areas or additional locations, with different dimensions, select the 'New Row' button.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

513.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

Ensure that the 28 day (or earlier if required) concrete compressive strength requirements have been satisfied in accordance with Section 509 of this Manual.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS

Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

Ensure that the curing requirements are complied with for the specified length of time. Refer to Section 513.04.H of the Standard Specifications. Be certain that the insulated blankets remain secure and that there is adequate water supply.

Monitor thermometers on the deck. If the temperature of the deck drops below 50 degrees F, take corrective actions.

Ensure that the Contractor protects the patched deck against premature loading until the concrete reaches its required strength in accordance with Section 504.04.H of the Standard Specifications for Class AA patches, and Section 701.20 of the Standard Specifications for all other classes.

Form removal must comply with Section 502.04.C of the Standard Specifications.

CHECKLIST – REPAIR OF CONCRETE BRIDGE DECKS

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
The Resident Engineer has approved the Contractor’s proposed mix design.					
The Resident Engineer has inspected and certified the Contractor’s proposed concrete plant.					
Portable plants have been properly permitted and inspected, as applicable.					
The Contractor’s proposed sources of materials are acceptable.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
The Contractor is using materials from approved sources.					
Expansion joints have the appropriate markings.					
The Contractor has provided adequate protection of traffic beneath repair areas.					
Existing overlays, asphalt, unsound concrete, and foreign materials have been satisfactorily removed from the deck surface.					
Patch geometries are acceptable (Figure 513:1).					
Exposed steel has not been cut, stretched, or otherwise damaged.					
Galvanic anodes are embedded at the perimeter of the patch to protect against corrosion.					
Spacing between anodes is limited to 24 inches.					
Sufficient clearance is provided between the anodes and the substrate to allow repair material to encase the anode.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
The anodes are adequately secured.					
Electrical continuity is established in the repair area.					
The Contractor implements cold weather practices, as applicable.					
The repair area is adequately cleaned and dried prior to patch placement.					
The Contractor places and finishes the repair concrete in accordance with the plans and specifications.					
Within 15 minutes of placing the patch, the Contractor covered the patch with insulating blankets. The insulating blankets are maintained until the concrete reaches compressive strength or 24 hours have elapsed.					
Repairs are water cured in accordance with Section 509.04.F(3).					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Concrete compressive strength requirements have been satisfied.					
Straightedge testing confirms that the surface does not vary more than ⅛ inch from the lower edge of the straightedge and the transverse slope of the pavement does not have depressions greater than ⅛ inch.					
Waste concrete or materials are disposed of properly (i.e., not in streams or waterways).					

SECTION 514 – DRIVEN FOUNDATION PILES

514.01 GENERAL

This work consists of providing and driving piles and cutting off or building up foundation piles of the type and dimensions required by the Contract.

This work also includes providing test piles, performing load tests, and providing and placing reinforcing steel, concrete-filled steel shell piles, and pipe piles.

The Department defines piles as steel H-piles, steel shell piles, steel sheet piles or precast concrete piles.

514.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Type and model of hammer proposed by the Contractor for driving piling.
- Basis of determining the required bearing of the piles. If by dynamic load testing, discuss who the Contractor proposes to perform the testing.
- Contractor's source of materials and Buy America requirements.
- Any field welding must be performed by a Department certified welder.
- Types of tips and splices that the Contractor proposes to use.
- If test piles are required in the Plans, Contractor's proposed sequence of operations.
- If exposed steel piling will be left in the finished structure (i.e. pile bents) the application of an approved paint system will be required.

B. Acceptance of Materials

1. All Steel Piling

Upon delivery, review the Mill Test Reports to ensure that the heat numbers on the piles correspond to those on the Reports and that the piles have been manufactured in the United States of America.

Materials Division will review the Mill Test Reports, recommend acceptance and submit the Mill Test Report and the Fabricator's Sheet to the Resident Engineer. The reviewed Mill Test Report will be signed, stamped and dated by Materials

Division. Excess steel piling from a project may be transferred to another project by the Resident Engineer. This will be accomplished by the Original Resident Engineer sending a letter to the Receiving Resident Engineer.

2. Precast Concrete Piling

None required by Residency. Inspection at the fabrication plant site will be handled by Materials Division or its representative.

Acceptance at the fabricator's facility, denoted by an inspection stamp, does not prevent subsequent rejection. The Resident Engineer may reject precast concrete piling not meeting Contract specifications, or which have been damaged during delivery or installation. The Contractor must immediately replace or correct rejected materials and work.

C. Preparatory Work and Contractor Work Plans

1. Contract Plans and Specifications

Review the Contract and Plans with respect to equipment requirements and pile type, length, location, orientation, anticipated driving depth, structural refusal, bearing capacity, and cut-off elevation. On bridges with integral abutments (no expansion joints) the abutment piling will be rotated to the weak axis (the web is perpendicular to centerline of the bridge). Care should be taken to rotate the piling as indicated in the Plans. Review the splicing, capping, and painting requirements. Typically test piles are not required; however if test piles are specified in the Plans, they will be used to determine the length of the piles used in the structure when unusual soil conditions are prevalent.

2. Pile Location and Utility Considerations

Verify that utility locations have been staked and that any known conflicts have been resolved before the operation begins. Review to ensure that all pile locations have been properly staked in accordance with the Contract.

3. Excavation or Embankment

Where excavation or embankment is required, check the limits of earthwork (i.e., plan dimensions and depth) for compliance. Unless otherwise authorized, earthwork must be completed and accepted in the vicinity of the piles prior to driving. Attention should be paid to the material used in any embankment to ensure that oversize material with diameters larger than 6 inches must not be used within 5 feet of structures or pile driving locations, in accordance with Section 202.04 of the Standard Specifications.

4. Equipment Considerations

Various types and energy ratings of pile drivers are available. Equipment selection depends on the type and size of piles to be driven. More than one type of driver may be required for the Project. Based on the methods and criteria specified in the Contract, the Resident Engineer will determine equipment acceptability before delivery to the job site in accordance with Sections 514.03.A(2) and 514.03.A(3) of the Standard Specifications, including Table 514:2.

This task generally involves analysis and comparison of data supplied by the Contractor and, if questionable, further inspection and testing (e.g., pile driving analyzer). As soon as practical, provide the Contractor with notification of equipment acceptance or rejection. Verify that the Contractor furnishes the pre-approved equipment and ensure that substitutions are not made during the work. Otherwise, equipment acceptability must be reassessed. The Contractor must submit pile driving equipment information to the Resident Engineer at least 30 calendar days before driving the piles, in accordance with Section 514.03A(1) of the Standard Specifications. The Resident Engineer will submit this information to Bridge Division for their permanent records.

5. Material Considerations

Use the following guidelines to inspect materials for the pile driving operation:

(a) Pile Types

The pile types that are typically used in foundation applications include structural steel shapes (H-piles), sheet piles, steel pipe, steel shell piles and concrete piles. The Contract will designate the types required. Also check and document conformance with respect to pile condition, material grade, length, and cross-sectional shape and dimensions.

(b) Pile Tips

Check pile tips and fastening details for compliance with the current standard drawings. If the Contractor proposes the use of a manufactured pile tip, they must receive prior approval from the Bridge Engineer.

(c) Concrete

Class AA Concrete is used to fill the interior of steel pipe and steel shell piles after they are driven and their interior cleaned of debris and water. Where specified, check the concrete class for conformance.

Class P Concrete is used for the construction of prestressed concrete piles in accordance with Section 503 of the Standard Specifications.

6. Test Piles and Pre-Drilling

When specified in the Plans, test piles will be used to determine the need for pre-drilling or to determine the length of the piles used in the structure when unusual soil conditions are prevalent. In general, if a test pile is driven to planned bearing without reaching the designated minimum penetration depth (typically minimum of 15 feet) and bearing elevation, pre-drilling will be required. Check and record the location, depth, and diameter of all pre-drilled holes. The hole diameter depends on the type and size of pile required. This ensures that the pile will be in an accurate and stable position for driving. Verify that voids from pre-drilled holes are backfilled as specified.

7. Welder Certification

As needed for splice or pile tip work, ensure that welders are prequalified for the work. All field welders must be approved by the Materials Division prior to any welding. Verify approval of all welders by reviewing the welders' Welder Operator Certification Card and determining if they have satisfactorily welded on a Department project within the last twelve months. A list of qualified welders is maintained by the Materials Division and is available in SiteManager.

Once the work has been satisfactorily completed, sign and date the welders' Welder Operator Certification Card.

D. Safety and Environmental Issues

Piling operations are dangerous. Before the Contractor's operations begin, review the Contractor's proposal for pile handling and driving. Contractor and inspection personnel must be properly equipped with adequate safety gear (hard hats, eye and hearing protection, footwear, etc.) when in the vicinity of the work. Care should be taken to evaluate the locations of any underground or overhead utility lines in the proximity of the pile handling and driving area.

514.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

1. All Steel Piling

Upon delivery, review the Mill Test Reports to ensure that the heat numbers on the piles correspond to those on the Reports and that the piles have been manufactured in the United States of America.

Materials Division will review the Mill Test Reports, recommend acceptance and submit the Mill Test Report and the Fabricator's Sheet to the Resident Engineer. The reviewed Mill Test Report will be signed, stamped and dated by Materials Division. Excess steel piling from a project may be transferred to another project by the Resident Engineer. This will be accomplished by the Original Resident Engineer sending a letter to the Receiving Resident Engineer.

Ensure that the paint system used by the Contractor to coat any exposed steel piling is on the ODOT APL in accordance with Section 512 of this Manual.

2. Precast Concrete Piling

None required by Residency. Inspection at the fabrication plant site will be handled by Materials Division or its representative.

Acceptance at the fabricator's facility, denoted by an inspection stamp, does not prevent subsequent rejection. The Resident Engineer may reject precast concrete piling not meeting Contract specifications, or which have been damaged during delivery or installation. The Contractor must immediately replace or correct rejected materials and work.

B. Equipment and Methods

Ensure that the equipment that is delivered to the Project for use in the pile driving operation is consistent with the equipment submittal sent to the Resident Engineer by the Contractor. Check the hammer and driving appurtenances for compliance with the Standard Specifications and manufacturer's recommendations and that they are in good working condition.

Various types and energy ratings of pile drivers are available. Ensure that the Contractor has submitted the appropriate energy rating chart for the equipment and type of piles being used.

1. Hammer Cushion/Capblock

Hammer cushions and capblocks are typically used to ensure uniform driving behavior and minimize damage to the pile. Ensure that impact pile driving equipment, except gravity hammers, are equipped with a hammer cushion conforming to the equipment submittal in respect to type and size. Add link

Hammer cushions are to be made from durable, manufactured material in accordance with the manufacturer's recommendations. The Department will not allow the use of wood, wire rope, or asbestos hammer cushions. A striker plate must be placed as recommended by the manufacturer on the hammer cushion to ensure uniform compression of the cushion material.

Inspect the hammer cushion at the start of pile driving at each structure or after each 100 hours of pile driving, whichever is less. The cushion must be replaced if the thickness is reduced by more than 25 % of the original cushion thickness. If any damage add link/pictures to the top of the pile is observed, the pile driving operation will be suspended and the cushion and other pile driving equipment will be reevaluated for compliance.

2. Pile Drive Head (Helmet)

When using impact hammers, the Contractor must provide drive heads that distribute the hammer blow evenly to the pile head.

During construction verify the following:

- The drive head is aligned axially (aligned with the centerline of the pile) with the hammer and pile.
- The leads guide the drive head.
- The drive head does not free-swing.
- The drive head is fit around the pile head to prevent torsional force transfers during driving.
- Hammer and pile are properly aligned.
- The steel piling heads are squarely cut.
- Using a drive head, hold the longitudinal axis of the pile in line with the hammer axis.

For precast concrete and prestressed concrete piles, the pile head should be perpendicular to the longitudinal axis of the pile to prevent eccentric impacts from the drive head.

To prevent damaging special types of piles, the Contractor should provide driving heads, mandrels, or other devices in accordance with the manufacturer's recommendations.

3. Pile Cushion

Pile cushions are only required when driving precast concrete piling. The Contractor must provide a new pile cushion for each concrete pile to prevent damage during driving. The pile cushions should distribute the hammer blow throughout the cross-section of the pile. If using plywood, at least 4 inches of plywood should be placed before driving.

The Contractor is to replace the pile cushion if driving burns or compresses the cushion by more than one-half the original thickness.

4. Pile Driving Leads

Pile driving leads are typically used to guide the movement of the hammer, thus ensuring the pile receives a concentric impact with each blow. It is essential that the fall of the hammer be in line with the pile; otherwise the head of the pile may be severely damaged, the hammer may be damaged, the energy of the hammer may be reduced, or the pile may change direction. Also, check lead alignment to ensure that it does not hinder the movement of the hammer.

Pile driving leads also maintain the orientation and alignment of the pile. Check during the driving operation for proper orientation and alignment, and direct the Contractor to make adjustments as necessary.

5. Water Jetting

Water jets, when specified by the Plans or authorized by the Resident Engineer, are used to facilitate pile penetration. Ensure that water jets are removed, as specified, for the final depth of penetration. Once removed, determine average penetration using test blows.

C. Construction Operations

1. General

Structural steel shapes are typically used as foundation piles. These piles are driven vertically or near vertically into natural ground to help support the structure and minimize settlement. Without a solid foundation, the attention given to constructing a quality structure is meaningless. As such, the Project Inspector must thoroughly and competently inspect the foundation piling provided for structures.

Though many types of piles are available, steel H-piles are normally used for foundation designs, and each design will differ based on the specific conditions at the site. The Contract will designate criteria such as pile type, number, length, horizontal arrangement, orientation (i.e., plumb, batter and rotation of the weak/strong axis), and driving specifications such as design load and depth. Each pile that is driven to specification will provide a bearing capacity that will support a fraction of the structure’s total load (i.e., design load). The pile’s bearing capacity results from a combination of resistant forces, including the surface friction between the pile and natural ground and the bearing pressure of the pile tip on the substrata material (e.g., bedrock).

Although it is equally important to check items such as pile type, location, and orientation, it is paramount to continually inspect the driving operation. If driving is stopped too soon, the pile will not have developed the required bearing capacity to resist the design load, and the structure may eventually settle due to a lack of support. If overdriven, the pile may incur structural damage, increasing the chance that the foundation will settle or otherwise fail at the location of the damaged pile. The procedures, methods, and criteria by which this determination is made will be specified in the Contract. In making this determination, the Project Inspector is only responsible for assisting the Resident Engineer, as directed.

Ensure that steel piling that is to be left exposed in the finished structure (i.e. pile bents) has received the prime coat of the approved paint system prior to driving. Any prime coat in the exposed steel piling damaged during driving, splicing or cutting must be repaired prior to the application of the remaining paint coats.

2. Pile Location and Direction

Verify that pile flanges are oriented as designated in the layout of the Contract.

Verify that each pile is driven within tolerance of its designated location and alignment.

- Bent Caps - within 2 inches of the location shown on the Plans
- Bridge Seats and Spread Footings - within 6 inches of the location shown on the Plans
- Final location must be at least 4 inches from any concrete surface
- Axial alignment must be within 1:50 from the vertical or the batter required by the Contract.

Watch the pile as it is driven for sudden changes in direction. This is a good indication that the pile has failed below the ground surface. In such cases, suspend the pile driving operations and contact the Bridge Division for assistance.

3. Pile Penetration and Bearing Elevation

Piles must be driven to the required ultimate bearing capacity specified in the Plans. At bridge structures over waterways, the bearing elevation of the pile must be below the 500-year scour depth. The bearing capacity and scour depth elevation are usually shown on the general plan and elevation sheet for the bridge. Check and document the final pile tip elevation, the final length of the pile left in place, and the final bearing capacity of each pile.

The ultimate bearing capacity of the pile is determined either by using the Engineering News-Record (ENR) formula method or the dynamic load test/wave equation analysis method and is to be performed in accordance with Section 514.04.E of the Standard Specifications.

When the ENR method is to be used, the Resident Engineer will perform the necessary calculations in accordance with the requirements of Table 514:4 of the Standard Specifications. It will be necessary to have the energy rating sheet for the specific hammer being used. Adjustments will be necessary depending on the stroke and the setting for the hammer. The required average penetration per blow, "S", will be calculated using this information for the last ten blows.

When the dynamic load test/wave equation analysis is to be used, it will be designated in the Contract by the pay item *PILE LOAD TEST DYNAMIC*, and the Contractor will be responsible for providing the required testing, analysis and results to the Resident Engineer. Discuss with the Contractor his sequence of operations to ensure that the dynamic testing is performed prior to approaching the planned ultimate bearing capacity. When dynamic load testing is being used, do not use the ENR formula or practical refusal to determine the pile bearing resistance.

Consider the additional following guidelines:

(a) Sudden Changes in Penetration

Monitor the pile for sudden changes in penetration between blows. This usually indicates that the pile has failed or an unusually soft subsurface strata has been encountered. Sudden disappearance of the pile confirms the presence of a cavern or large void. In such cases, contact the Bridge Division for assistance.

(b) Unusually High Bedrock

Where the designated penetration depth and bearing elevation cannot be obtained without damaging the pile (e.g., encounter with unusually high bedrock), contact the Bridge Division for assistance. Pre-drilling may be required. Typically the minimum length of pile required is 15 feet with no less than 12 feet under any circumstances.

(c) Springing/Bouncing

Watch for pile springing and hammer bouncing. Springing may occur where spliced members are not properly aligned, the pile head is not squared properly, or the pile and hammer are misaligned. Bouncing may occur where the pile has reached the point of practical refusal, a hammer of insufficient weight is used, or too much steam or air pressure is used in double-acting hammers.

4. Cutting of Piles

Ensure that the tops of permanent piles and pile casings are cut at the elevations shown on the Plans. Embedded piles must be cut clean and straight, parallel to the bottom face of the structural member. All damaged or deformed pile should be removed or repaired prior performing the field splice, as shown in Figure 514:1. Check that the cuts made for splices are perpendicular to the longitudinal axis of the pile.

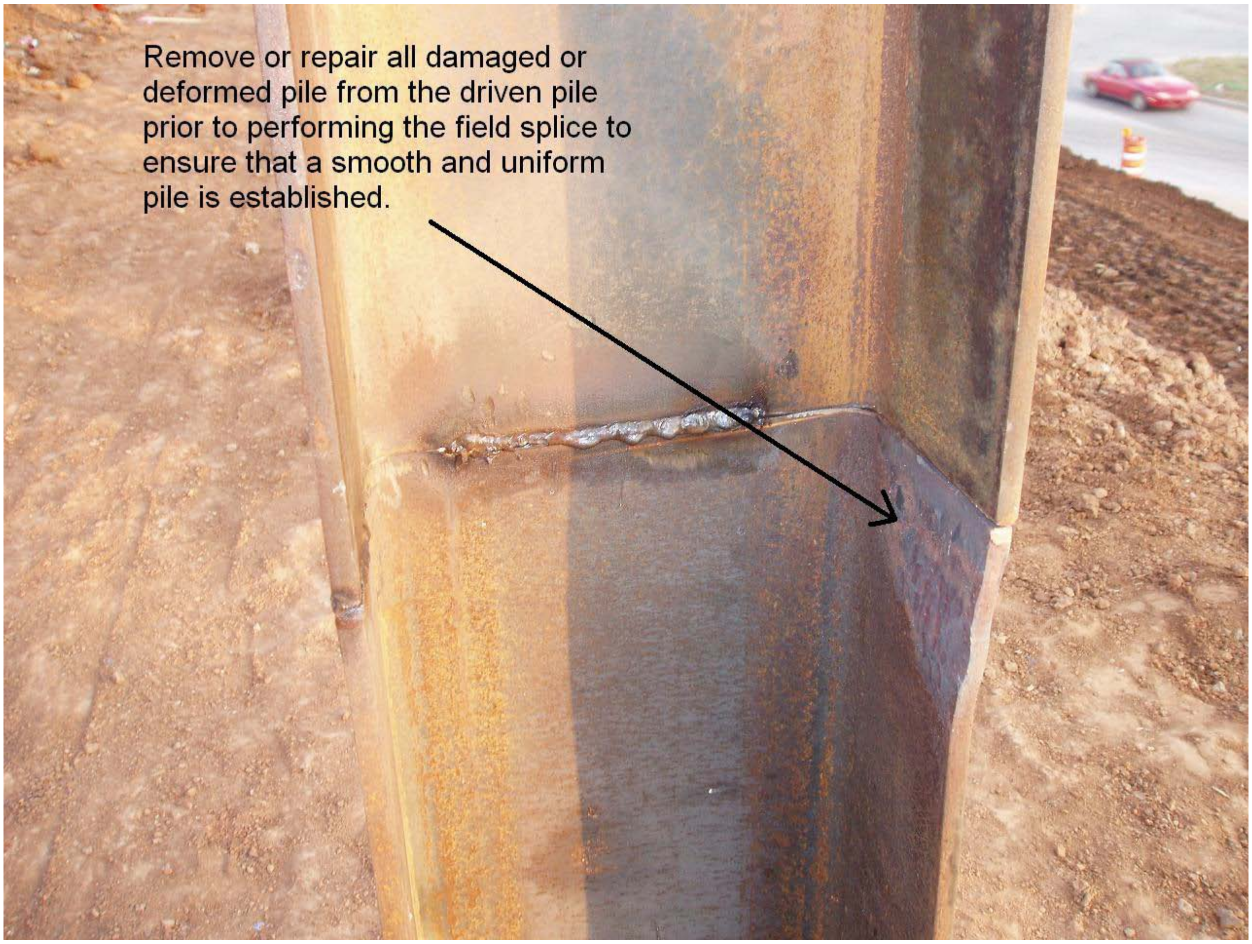


Figure 514:1. Photo. Need to Repair Damaged/Deformed Pile

Document the pile location, the pile's initial length, and the length of pile that was cut. Pay particular attention to the disposition of cut lengths of piles. Cutoff lengths of piling may be reused only for extensions beyond the plan length for other piles and must not be damaged (curled, split, etc.). If reused in field-splice work, document the pile location and the length of pile that was reused.

5. Pile Splicing

For those piles driven deeper than the minimum penetration depth, splicing may be necessary to raise the top of the pile to the correct cut-off elevation. The number of splices allowed to achieve plan length is defined in Table 514:3 of the Standard Specifications. Field-welded splices must be used in accordance with the standard drawings. Refer to Figure 514:2 and Figure 514:3.

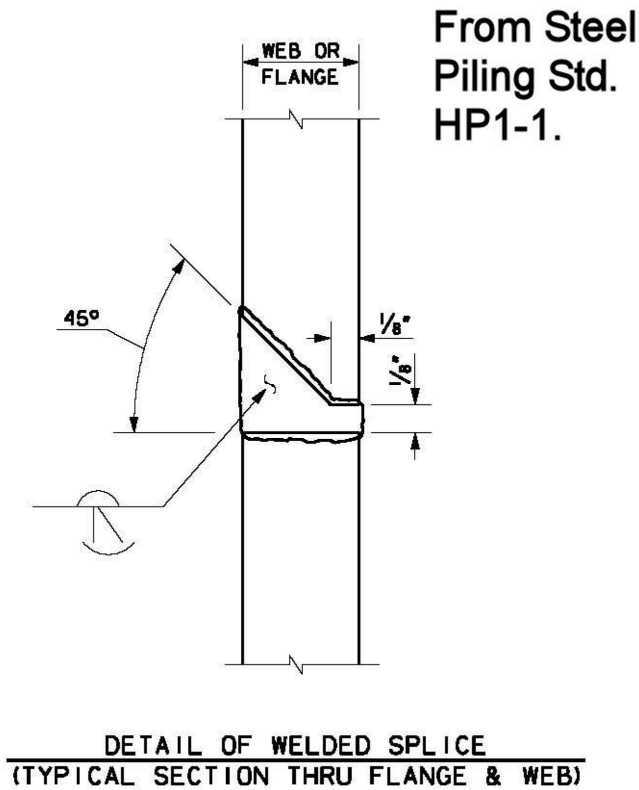


Figure 514:2. Drawing. Welded Splice Detail

Figure 514:3. Photo. Unacceptable Field Splice

Document the location and the number of all splices. Thoroughly inspect welding for compliance with respect to welder certification, surface preparation, root opening, welding method, type of weld, number and order of passes, and removal of slag. Direct the Contractor to remove any loose scale, slag, or other materials, such as that exhibited in Figure 514:4, that could prevent a proper weld. Ensure the opening is not built up with foreign materials (welding rods, reinforcing steel, etc.).

Figure 514:4. Photo.

All field welders must be approved by the Materials Division prior to any welding. Verify approval of all welders by reviewing the welders' Welder Operator Certification Card and determining if they have satisfactorily welded on a Department project within the last twelve months. A list of qualified welders is maintained by the Materials Division and is available in SiteManager.

Once the work has been satisfactorily completed, sign and date the welders' Welder Operator Certification Card.

6. Filling and Capping of Hollow Piles

After steel pipe, shell piles, and the adjacent piles have been driven and accepted, inspect the inside cavity using the Contractor-supplied lighting system. Pay particular attention to buckling or crushing. Ensure that water and debris are removed from within the pile before the Contractor fills the interior with the Class AA concrete.

7. Pile Damage and Defects

During the driving operation, continually monitor piles for damage and defects, and review the provisions of the Contract with respect to corrective work. Pay particular attention to head damage, internal damage, splice defects, and improper pile location, direction, and final bearing elevation. If lifting holes are not cut off and remain in the length of the permanent pile, they should be repaired by field welding two plates over the hole; do not allow plug welding of these holes. Contact the Resident Engineer and the Bridge Division as needed for assistance. Defective piles may need to be removed and replaced, or they may be permitted to remain with the provision of another treatment (e.g., new adjacent pile, footing adjustment, additional extension). Note any unusual conditions encountered. Re-inspect all corrective work.

D. Safety and Environmental Considerations

Piling operations are dangerous. During the operations ensure the Contractor is complying with its proposal for pile handling and driving. Verify the Contractor and inspection personnel are properly equipped with adequate safety gear (hard hats, eye and hearing protection, footwear, etc.) when in the vicinity of the work. Care should be taken to evaluate the locations of any underground or overhead utility lines in the proximity of the pile handling and driving area.

E. Documentation

1. Daily Work Report

Significant information will need to be documented with respect to pile driving. See Appendix XX for an example of a completed Piling Form.

Record the following information, as appropriate:

- Location of piling driven or tested (i.e. Bridge ‘A’ - Abutment #1 - Pile #3)
- Any conditions requiring corrective actions, and individual contacted and their recommendations
- Document who performs the corrective actions

- Verify and document welder's certification
- Document performance of dynamic load or static load testing

2. Measurement and Payment

(a) Linear Foot Unit of Measure Pay Items

Documentation of these items will be performed within the SiteManager / Daily Work Reports / Work Items tab, utilizing an Excel spreadsheet provided by Construction Division.

Special attention needs to be paid to the Piles Furnished pay item and the limitations placed on this item in accordance with section 514.05.B of the standard specifications. Piles Furnished is the sum of planned pile lengths for a specific pile type as shown on the Plans or approved by the Bridge Division. For steel piles, the Piles Furnished quantity will equal the Piles Driven quantity if the as-built Piles Driven quantity exceeds the total plan length.

Measure the length of Piles Driven complete in place. The cost of driving and cutting off piles will be included in the contract unit price for Piles Driven. Any cut off length will be recorded on the Excel spreadsheet.

When utilizing the DWR Work Items Tab document as follows:

1. Select the appropriate pay item from the list of contract pay items.
2. In the appropriate field, enter the descriptive location (i.e. Bridge 'A' - Abutment #1 - Pile #3) or the station and location.
3. In the Placed Quantity field enter the linear foot of work complete in place.

(b) Each Unit of Measure Pay Items

Documentation of these items will be performed within the SiteManager / Daily Work Reports / Work Items tab.

1. Select the appropriate pay item from the list of contract pay items.

2. In the appropriate field, enter the descriptive location (i.e. Bridge ‘A’ - Abutment #1 - Pile #3) or the station and location.

3. In the Placed Quantity field enter the number of Pile Load Tests, Metal Pile Shoes or Pile Splices complete in place. This quantity will either be as shown on the plans or as actual counted in place, if the item is not specified as Pay Plan Quantity.

The cost of all splices required to achieve plan length, and as allowed by Table 514:3 of the Standard Specifications, is included in the unit price bid for Piles Driven.

One steel piling splice on an individual pile will be measured for payment for piling extensions beyond plan length. The following conditions must be met before measuring the steel piling splice for payment:

- The plan length on an individual pile has been driven,
- The required bearing capacity for an individual pile has not been achieved at the plan length, and
- The splice is produced after condition 1 and 2 have been met.

In the SiteManager / Daily Work Reports / Work Items tab / Remarks Bubble, provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown.

(c) Square Yard Unit of Measure Pay Items

Documentation of these Square Yard items will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template.

1. Select the appropriate pay item from the list of contract pay items.

2. Open the ‘DWR Templates’ icon in the toolbar.

3. Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to be used as the method of documentation for the work performed.

4. Select the appropriate method of measurement from the Type radio button options. Depending on the option selected, enter the following information:

   a. Two Dimensional Measured Quantity Option.

This option can be used to allow the template to calculate areas for progressive payments or for documenting the final quantity. Typically this option will be used for areas involving simple calculations which will only require length and width.

(1) In the appropriate fields, enter both a descriptive location and the station to station extents.
(2) Input the measured length and width to calculate an area.
(3) For additional areas or additional locations, with different dimensions, select the 'New Row' button.

b. Calculated Quantity Option.

This option will allow the input of quantities calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), and can be used for progressive payments or for documenting the final quantity of areas. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

(1) In the appropriate fields, enter both a descriptive location and the station to station extents.
(2) In the Placed Quantity field, enter the calculated quantity (SY) of the item completed.
(3) In the Book/Folder/Envelope # field provide the location of the documentation for the calculations.
(4) For additional areas or additional locations, with different dimensions, select the 'New Row' button.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

(d) Lump Sum Unit of Measure Pay Items

Documentation of these Lump Sum items will be performed within the SiteManager / Daily Work Reports / Work Items tab.

1. Select the appropriate pay item from the list of contract pay items.

2. In the appropriate field, enter the descriptive location (i.e. Bridge 'A' – Span #1) or the station to station extents and location.

3. In the Placed Quantity field, enter an estimated percentage of the lump sum item completed, ensuring that the total quantities to date does not exceed 1.00 Lump Sum.

In the SiteManager / Daily Work Reports / Work Items tab / Remarks Bubble, provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown.

(e) Documentation Procedures for the Driven Foundation Piles Pay Items

1. Piles, Furnished (LF) - This pay item will be documented utilizing the DWR template for Linear Foot (LFT) or the DWR Work Items tab.

2. Piles, Driven (LF) - This pay item will be documented utilizing the DWR template for Linear Foot (LFT) or the DWR Work Items tab.

3. Test Piles, Furnished (LF) - This pay item will be documented utilizing the DWR template for Linear Foot (LFT) or the DWR Work Items tab.

4. Test Piles, Driven (LF) - This pay item will be documented utilizing the DWR template for Linear Foot (LFT) or the DWR Work Items tab.

5. Pile Load Test (Static) (EA) - This pay item will be documented utilizing the DWR Work Items tab.

6. Pile Load Test (Dynamic) (EA) - This pay item will be documented utilizing the DWR Work Items tab.

7. Metal Pile Shoes (EA) - This pay item will be documented utilizing the DWR Work Items tab.

8. Sheet Piling, Furnished (SY) - This pay item will be documented utilizing the DWR template for Square Yard (SqYd).

9. Sheet Piling, Driven (SY) - This pay item will be documented utilizing the DWR template for Square Yard (SqYd).

10. Temporary Sheet Piling (LSUM) - This pay item will be documented utilizing the DWR Work Items tab.

11. Pilot Holes (LF) - This pay item will be documented utilizing the DWR template for Linear Foot (LFT) or the DWR Work Items tab.

12. Pile Splice (Non-Biddable) (EA) - This pay item will be documented utilizing the DWR Work Items tab.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

514.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

The Contractor must provide a Buy America certification in accordance with Section 106.01(b) of the Standard Specifications and provide documentation for any foreign steel incorporated into the Project.

Ensure that the paint system used by the Contractor to coat any exposed steel piling is on the ODOT APL in accordance with Section 512 of this Manual.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

Verify that each pile is driven within tolerance of its designated location and alignment:

- Bent Caps - within 2 inches of the location shown on the Plans
- Bridge Seats and Spread Footings - within 6 inches of the location shown on the Plans
- Final location must be at least 4 inches from any concrete surface

If any of these are noted to be out of tolerance, contact Bridge Division for corrective action recommendations.

Ensure that all loose material is removed from around the piles before the foundation concrete is poured.

Verify that any prime coat in the exposed steel piling damaged during driving, splicing or cutting is repaired prior to the application of the remaining paint coats, and the intermediate and top coats are applied in accordance with Section 512 of the Standard Specifications.

CHECKLIST – DRIVEN FOUNDATION PILES

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
For steel piling, heat numbers on the piles correspond to those in the Mill Test Reports.					
Steel piles have been manufactured in the United States.					
Precast concrete piles have been inspected by the Materials Division and bear an inspection stamp.					
Utility locations have been staked and all known conflicts have been resolved.					
Earthwork in the vicinity of the piles has been completed and accepted before the Contractor begins driving piles.					
Oversize material (diameters exceed 6 inches) are not used within 5 feet of pile driving locations.					
The Resident Engineer has determined that the Contractor's proposed pile driving equipment is acceptable.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
The Contractor is using the pile type and pile tips specified in the Contract.					
The Contractor provides driving heads, mandrels, or other devices in accordance with the manufacturer's recommendations.					
The longitudinal axis of the pile is held in line with the hammer axis using a drive head.					
The leads guide the drive head.					
The drive head does not free-swing.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
The drive head is fit around the pile head to prevent torsional force transfers during driving.					
Hammer and pile are properly aligned.					
The steel piling heads are squarely cut.					
The Contractor uses new pile cushions when driving precast concrete piling (i.e., new cushion for each concrete pile).					
Piles exhibit no sudden changes in direction during driving.					
Piles are driven to specification (e.g., type, number, location, length, orientation, design load, penetration depth)					
Piles are driven to the required ultimate bearing capacity.					
Welders have proper certification.					
Field splices are performed properly.					
Tops of permanent piles are cut to the elevation shown in the Plans.					
Contractor removes water and debris from within the pile before filling with concrete.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Each pile is driven within tolerance of its designated location and alignment.					
All loose material is removed from around the piles before foundation concrete is poured.					

SECTION 515 – PENETRATING WATER REPELLENT TREATMENT

515.01 GENERAL

This work consists of treating concrete surfaces with a penetrating water repellent treatment solution.

515.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Contractor's proposed methods of traffic control, surface preparation, and water repellant treatment.
- Contractor's source of materials, material safety data sheets (MSDS) and product data sheets (PDS).
- Equipment requirements.
- Contractor's personnel are to be certified by the water repellent manufacturer to clean the concrete surface and apply the water repellent solution.
- Contractor's proposed schedule for work and any restrictions detailed in the Plans and Contract.
- Resident Engineer must approve the surface preparation before the Contractor may apply the penetrating water repellent treatment.
- Mix design for core hole repair must be approved by the Resident Engineer.

B. Acceptance of Materials

The Resident Engineer must ensure that the Contractor's proposed source of material is on the APL.

C. Preparatory Work and Contractor Work Plans

The Contractor must allow the concrete to cure for at least 28 days before applying surface treatment. After rain or water cleaning, the concrete surfaces must be allowed to dry for at least 8 hours before applying penetrating water repellent treatment solution.

For formed surfaces, the penetrating water repellent treatment must be applied after applying Class 1 through Class 6 concrete surface finishes, and before applying a Class 7 paint finish. Refer to Section 509.04.G of the Standard Specifications for definitions of surface finish classes.

Ensure all foreign materials are removed from the concrete surfaces. The Contractor may need to employ alternate methods to remove any materials that will not be removed by its proposed method of surface preparation.

If crack sealing is required by the plans, the water repellant must be applied prior to crack sealing.

D. Safety and Environmental Issues

Discuss with the Contractor its plan to protect workers and traffic during construction. This plan should address the following:

- Method to shield traffic from surface preparation debris and water repellant application overspray,
- Traffic control during construction,
- Fall protection for workers,
- Prevention of tools, material etc. from falling on traffic beneath, and
- Collection, storage and disposal of concrete slurry, if any, produced by the surface preparation techniques.

515.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

The Resident Engineer must ensure that the Contractor's proposed source of material is on the APL.

1. Visually Inspected

The Resident Engineer must ensure that the Contractor's proposed source of material is on the APL. [Document in Template AM5001]

2. Performance Tested

The Resident Engineer must ensure that the Contractor's proposed source of material is on the APL. Obtain two 4 inch by 4 inch core samples per 20,000 square foot lot with a minimum of two lots per bridge in accordance with Section 515.04.C of the Standard Specifications. [Document in Template C94005 and C 94006] [add link to QRG]. The cores are to be cut by the Contractor under the supervision of the Inspector. Before coring, locate rebar in the bridge deck and approach slabs to avoid rebar during coring. Ensure that the cores are properly labeled (bridge designation, lot number and core number) and submitted to Materials Division for testing.

Materials Division will perform appropriate tests on the bridge cores, and complete and authorize the test templates.

B. Equipment and Methods

Ensure that the Contractor uses at least one of the following types of equipment for surface preparation:

- Sand-Blasting - an oil-free compressed air pressure sand-blaster
- Shot-Blasting - a portable machine that uses a recyclable steel shot blast technique

- Hot Water Pressure Washer - a hot water pressure system with water at least 160 degree F and a nozzle pressure of 2,500 psi
- Hydroblast Washer - a high pressure cold water washer unit using 7,000 psi nozzle pressure
- Steam Cleaning - a steam jet that uses at least 320 degrees F water under an operating pressure of 300 psi

For water repellent application, ensure the Contractor provides low pressure airless spray equipment with an application pressure from 15 psi to 40 psi.

C. Construction Operations

1. General

Before starting work, ensure the Contractor has provided the following information:

- Water repellent, including: brand name, manufacturer's name, and a copy of the MSDS and PDS
- Equipment
- Surface preparation methods
- Manufacturer's application procedures
- Weather limitations
- Water repellent manufacturer's certified personnel

2. Surface Preparation

Poor surface preparation is one of the main causes of water repellent treatment failure. When the water repellent is applied to a damp, dusty or contaminated surface, the water repellent can not properly penetrate the concrete surface.

Monitor the distance between the concrete surface and the Contractor's cleaning equipment to ensure the surface is being properly cleaned without damage (i.e. using a 7,000 psi water blast from 6 feet away does not gain the level of cleanliness needed to attain proper absorption, while holding the nozzle 2 inches away from the surface may cause serious damage to the concrete).

The concrete can be checked for the presence of non-visible coatings (such as curing compounds) that may affect the absorption of the water repellent into the concrete. This may be done by applying a small amount of muriatic acid to the concrete surface. You can tell that the acid is in contact with concrete (i.e. not curing compound) if it foams. Remember you need to rinse the test area with an ammonia solution to neutralize the acid.

Ensure the Contractor removes all foreign materials from the concrete surfaces and prepares the surfaces in accordance with the manufacturer's PDS before applying the water repellent treatment. Solvents and hand tools should be used to remove bonded materials detrimental to concrete surface treatment.

If detergents are added to the cleaning water ensure that they do not exceed 2% by weight of water.

Ensure the Contractor provides a uniform surface color by removing all stains.

After cleaning with water, the Contractor must remove excess moisture that may delay surface drying or inhibit surface penetration for the water repellent.

3. Application

(a) Preapplication Requirements

The Resident Engineer must inspect and approve the surface preparation immediately prior to the Contractor's application of the water repellent.

Ensure the concrete surfaces have been allowed to dry after rain or water cleaning for at least 8 hours before applying penetrating water repellent.

Verify that the water repellent is impregnated with a fugitive dye and is properly stored in accordance with the PDS and MSDS.

(b) Application

The water repellent must be used as supplied by the manufacturer without dilution or alteration of the solution.

Verify a flood coat of the water repellent is sprayed onto concrete surfaces at a rate recommended by the manufacturer to obtain the required depth of penetration. The application rate will need to be adjusted for vertical, tined, grooved or roughened surfaces.

Monitor the consistency of the fugitive dye in the water repellent to gauge the uniformity of application. Require the Contractor to re-treat areas with inadequate coverage.

(c) Weather Limitations

Ensure the water repellent is applied in accordance with Table 515:1 of the Standard Specifications (see below) and the manufacturer's recommendations, whichever is more restrictive.

Table 515:1
Acceptable Weather Conditions During Application

Weather Condition	Acceptable Range
Temperature: air or concrete surface	Above 40 degrees F and within the manufacturer's recommended application temperature range
Wind speed	Below 25 miles per hour
Precipitation	None

D. Safety and Environmental Considerations

Ensure the Contractor is in compliance with its plan to protect workers and traffic during construction. This includes the following actions:

- Shielding traffic from surface preparation debris and water repellant application overspray,
- Providing traffic control during construction,
- Proving fall protection for workers,
- Preventing tools, material etc. from falling on traffic beneath, and
- Collecting, storing and disposing the concrete slurry, if any, produced by the surface preparation techniques.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location or Structure Number and the type of work being performed.
- Verify and document the applicator's qualification
- Weather conditions and concrete surface temperatures.
- Any conditions requiring corrective actions, location of correction as well as individual contacted and their recommendations
- Document who performs the corrective actions
- Document performance of coring for acceptance testing
-

2. Measurement and Payment

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

Documentation of these Square Yard items will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template.

1. Select the appropriate pay item from the list of contract pay items.

2. Open the 'DWR Templates' icon in the toolbar.

3. Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to

be used as the method of documentation for the work performed.

4. Select the appropriate method of measurement from the Type radio button options. Depending on the option selected, enter the following information:

    a. Two Dimensional Measured Quantity Option.

    This option can be used to allow the template to calculate areas for progressive payments or for documenting the final quantity. Typically this option will be used for areas involving simple calculations which will only require length and width.

    (1) In the appropriate fields, enter both a descriptive location and the station to station extents.
    (2) Input the measured length and width to calculate an area.
    (3) For additional areas or additional locations, with different dimensions, select the 'New Row' button.

    b. Calculated Quantity Option.

    This option will allow the input of quantities calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), and can be used for progressive payments or for documenting the final quantity of areas. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

    (1) In the appropriate fields, enter both a descriptive location and the station to station extents.
    (2) In the Placed Quantity field, enter the calculated quantity (SY) of the item completed.
    (3) In the Book/Folder/Envelope # field provide the location of the documentation for the calculations.
    (4) For additional areas or additional locations, with different dimensions, select the 'New Row' button.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

There are two different pay items provided for the acceptance of this pay item; Visually Inspected and Performance Tested.

- When the pay item is Visually Inspected (bridge rails, abutments, pier caps, etc.), the Inspector will verify the application by witnessing the areas covered by the fugitive dye in the solution.
- When the pay item is Performance Tested (bridge decks and approach slabs), the contractor is required to cut cores from the area treated and provide them to the Department for testing. The results of the performance tests will be used to calculate pay factors in accordance with section 515.04.D(2) of the standard specifications. Any resulting deductions will be documented in SiteManager by Line Item Adjustment or by change order. Any incentives earned must be documented by change order. The calculations for these adjustments will be placed in a Book, Folder or Envelope, or as an attachment to the change order.

515.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

The Contractor may elect to retreat lots at its own expense, if the performance test results from Materials Division indicate a pay reduction. Lots retreated must be resampled and retested in accordance with the guidelines in Section 515.03.A of this Manual.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

Ensure the Contractor keeps traffic off the treated surfaces until the water repellent dries.

Verify the core holes for testing are filled in accordance with the following:

- The cement mortar mix design has been approved by the Resident Engineer.
- The cement mortar consists of portland cement, concrete sand, water, and acrylic polymer binder.
- The cement mortar is proportioned in accordance with the manufacturer's recommendations of the acrylic polymer binder.
- The cement mortar is placed the day the cores are taken.
- The patch surface is treated with water repellent after curing.

CHECKLIST – PENETRATING WATER REPELLENT TREATMENT

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
The Contractor has submitted the MSDS and PDS for its proposed treatment solution.					
The Contractor is adequately protecting and storing the treatment solution in accordance with the manufacturer's recommendations.					
The Contractor employs personnel certified by the treatment solution manufacturer to clean the concrete surface and apply the solution.					
The Contractor is taking adequate precautions to control traffic and prevent overspray.					
The Resident Engineer has approved the mix design for core hole repair.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
The surface has been adequately cleaned and prepared in accordance with the manufacturer's recommendations.					
All excess moisture has been removed from the surface.					
Weather conditions are acceptable for treatment application.					
The water repellant is applied at the rate recommended by the manufacturer to achieve the necessary depth penetration.					
A uniform application of water repellant has been achieved.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
The surface treatment is satisfactory, as demonstrated by core testing.					
Core holes have been adequately repaired.					

SECTION 516 – DRILLED SHAFT FOUNDATIONS

516.01 GENERAL

This work consists of constructing drilled shafts and providing and placing reinforcing steel and concrete.

516.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Contractor must submit an installation plan to the Resident Engineer prior to beginning drilled shaft construction in compliance with Section 516.04.A of the Standard Specifications.
- Contractor's mix design. The Contractor must provide and modify Class AA concrete as follows:
    - For concrete placed under water or slurry, the minimum cement content must be increased by 10 percent.
    - The Water/Cement Ratio must be at or below 0.44
    - A High Range Water Reducing admixture must be used to achieve 6 to 8 inches of slump at the start of placement.
    - A set retarder must be used to ensure at least 4 inches of slump exists at the completion of placement and casing or reinforcement alignment.
    - The concrete temperature must be maintained below 85 degrees F during placement.
- Contractor's source of materials.
- Contractor's proposed schedule for work and any restrictions detailed in the Plans and Contract.
- No concrete will be placed until a pre-placement check is held and approved by the Resident Engineer. The Inspector must be present for all concrete pours.
- Method and frequency of acceptance testing during any placement. Inform the Contractor what is expected if non-acceptable material is found during placement.
- If Cross Hole Sonic Logging (CSL), Impact Echo Testing (PIT) or other non-destructive testing methods are required, discuss with the Contractor their choice for testing firm and their procedures.

B. Acceptance of Materials

1. Concrete Mix Design

The Contractor must submit its proposed concrete mix designs. The Resident Engineer will approve the concrete mix design in accordance with Section 701.01.C of the Standard Specifications. As soon as practical, the Residency should obtain sufficient samples of aggregates to be utilized and perform applicable tests on these materials.

Concrete mix designs have special requirements that may be found in Section 516.02.B of the Standard Specifications. Ensure the Contractor's Class AA concrete mix design includes the following:

- For concrete placed under water or slurry, the minimum cement content is increased by 10 percent.
- Water/Cement Ratio must be at or below 0.44
- Use of a High Range Water Reducing admixture to achieve 6 to 8 inches of slump at the placement start. Ensure at least 4 inches of slump exist at the completion of placement and casing or reinforcement alignment.
- The concrete temperature is maintained at or below 85 degrees F during placement.

2. Concrete Plants

The Resident Engineer will inspect and certify the proposed concrete plant in accordance with Section 414.03.A of the Standard Specifications, and submit this information to the Materials Division. If a portable plant is mobilized to the project, the Resident Engineer must notify the Oklahoma Department of Environmental Quality and the Materials Division in accordance with Section 509 of this Manual. The purpose of the notice is to ensure that the plant(s) are properly permitted and inspected for emissions by ODEQ, and that they are accurately tracked within ODOT's databases.

3. Sources of Materials

The Contractor must submit its proposed sources of materials. The Residency will verify that the proposed sources of materials are on the Approved Products List (APL). If a proposed source is not on the APL, the Resident must contact Materials Division immediately. Verify the APL for the following:

- Structural Concrete – source for each individual component, in accordance with Section 509 of this Manual
- Reinforcing Steel
- Curing Materials

4. Permanent Steel Casing

Upon delivery, review the Mill Test Reports to ensure that the heat numbers on the steel casing correspond to those on the Reports and that the steel casings have been manufactured in the United States of America.

Materials Division will review the Mill Test Reports, recommend acceptance and submit the Mill Test Report and the Fabricator's Sheet to the Resident Engineer. The reviewed Mill Test Report will be signed, stamped, and dated by Materials Division. Excess steel casings from a project may be transferred to another project by the Resident Engineer. This will be accomplished by the Original Resident Engineer sending a letter to the Receiving Resident Engineer.

C. Preparatory Work and Contractor Work Plans

Drilled shafts are relatively large-diameter, underground columns of reinforced concrete that are constructed in pre-drilled holes to provide foundation support for structures. They are designed to transfer and distribute structural loads to underlying strata through side shear and end bearing. In general, drilled shaft construction consists of drilling a hole at a designated location, depth, and diameter; constructing and placing a cage of reinforcing steel; and placing and finishing concrete to the elevation required by the foundation details of the Contract.

Verify that utility locations have been staked and that all drilled shaft locations do not conflict with any underground utilities. Ensure that no overhead utilities conflict with the drilled shaft construction operations and equipment.

The Inspector should review the boring log and geological information included in the Plans, and become familiar with the appearance of the type of material anticipated at the depth of the bearing strata (i.e., the material the Plans specify a minimum depth of penetration into – usually labeled as the "Interpreted Rock Line" on the General Plan and Elevation sheet).

Before constructing drilled shafts, the Contractor must submit an installation plan. The Resident Engineer and the Inspector must review this plan and evaluate the following details:

- The plan must identify Contractor's personnel having experience in constructing drilled shafts. Plan should include personnel resumes of project experiences and documentation that verifies the information.

- The plan must detail the Contractor's concrete mix design, including results of concrete trial mix and tests for slump loss over time. Procedures for introducing admixtures during mixing operations need to be discussed and formalized. A set retarder must be used to ensure at least 4 inches of slump exists at the completion of placement and casing or reinforcement alignment. The first load of concrete placed eventually becomes the concrete at the top of the drilled shaft.

- The Plan must list the Contractor's proposed equipment, including cranes, drills, augers, bailing buckets, final cleaning equipment, desanding equipment, slurry pumps, core sampling equipment, tremies, concrete pumps, and casings. Analyze the capacity of the equipment to drill the size, depth, and hardness of the planned excavations. The list of equipment to be used will be dependent upon the method of excavation (i.e. slurry).

- The plan must identify the type of casings to be used by the Contractor in accordance with Section 516.02.C of the Standard Specifications. Permanent casings must be designed and stamped by a Professional Engineer. On deep drilled shafts, CGMP may not be able to withstand the fluid pressures exerted by the concrete. Ensure the Contractor has the permanent casing designed for the fluid pressures to be encountered. Contact the Bridge Division for assistance in evaluating this proposal. If temporary casing is longer than 60 feet, the Contractor must include in the plan a method for removing the casing without damaging the drilled shaft.

- The Contractor should describe in the plan its shaft excavation methods and procedures for maintaining horizontal and vertical alignment of the excavation.

- When the slurry method is used, the plan should include details of the methods to mix, circulate, desand, and dispose of the slurry.

- The plan should include details of how the Contractor intends to clean the shaft excavation, and use or dispose of the excavated materials. It is critical that the bottom of the shaft excavation is clear of any loose material prior to placement of reinforcing and concrete. Likewise, it is important to ensure that the Contractor will not dispose of excavated material within a stream bed (see Figure 516:1). Such disposal could be a violation of the USACE 404 permit.

Figure 516:1. Unacceptable Disposal of Waste Materials in Stream Bed

- The plan should describe how the Contractor will place reinforcing steel, including support and centering methods required to minimize lateral movement of the steel cage. Concrete rollers must be used unless otherwise approved by the Bridge Division. The use of plastic rollers, metal chairs, etc. will not be allowed. Concrete sleds are acceptable in lieu of the rollers when casing is used down to the rock line.

- The plan addresses concrete placement, including proposed operational procedures for tremie and pumping methods. The plan should describe the manner in which the Contractor will verify the outlet end is at least 5 feet into the fluid concrete. For a dry shaft, at least 1 foot of concrete should overflow the top, and for a wet shaft, at least 5 feet of concrete should overflow the top. The Contractor should continue to overflow concrete in shafts until uncontaminated concrete is evident at the top of the shaft. It is critical that this material is recovered and disposed of properly.

The Contractor must resubmit the installation plan if it does not produce Contract required results. Requests for changing the top of shaft elevations should be submitted with the installation plan.

D. Safety and Environmental Issues

Discuss with the Contractor its plan to protect workers and traffic during construction. This plan should address the following:

- Providing fall protection for workers,
- Preventing tools, material etc. from falling into the excavated shaft, and
- Proper disposal of excavated material, slurry and excess concrete.

516.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

1. Concrete Mix Design

Ensure the Resident Engineer has approved the concrete mix design in accordance with Section 701.01.C of the Standard Specifications. Any changes to the approved concrete mix design, including substitution of material sources, must be approved by the Resident Engineer.

Concrete mix designs have special requirements that may be found in Section 516.02.B of the Standard Specifications. Ensure the Contractor's Class AA concrete mix design includes the following:

- For concrete placed under water or slurry, the minimum cement content is increased by 10 percent.
- Water/Cement Ratio must be at or below 0.44

- Use of a High Range Water Reducing admixture to achieve 6 to 8 inches of slump at the placement start. Ensure at least 4 inches of slump exist at the completion of placement and casing or reinforcement alignment.
- The concrete temperature is maintained at or below 85 degrees F during placement.

2. Concrete Plants

Ensure that the concrete plant has been certified in accordance with Section 414.03.A of the Standard Specification.

3. Sources of Materials

Ensure the Contractor has submitted its proposed sources of materials. The Residency will verify that no changes were made from the proposed sources of materials and they are still on the APL. If a proposed source is not on the APL, the Resident must contact Materials Division immediately.

Document or perform applicable tests as follows:

- Structural Concrete – sample and test for each individual component, in accordance with Section 509.03.A of this Manual. The Inspector will sample concrete for acceptance at the point of discharge into the tremie or concrete pump hopper.
- Reinforcing Steel – accept in accordance with Section 511.03.A of this Manual
- Curing Materials - ensure that they are provided from an approved source, as shown in the APL. [Document in Template AM5001]

4. Permanent Steel Casing

Upon delivery, review the Mill Test Reports to ensure that the heat numbers on the steel casing correspond to those on the Reports and that the steel casings have been manufactured in the United States of America.

Materials Division will review the Mill Test Reports, recommend acceptance and submit the Mill Test Report and the Fabricator's Sheet to the Resident Engineer. The reviewed Mill Test Report will be signed, stamped and dated by Materials Division. Excess steel casings from a project may be transferred to another project by the Resident Engineer. This will be accomplished by the Original Resident Engineer sending a letter to the Receiving Resident Engineer.

5. Crosshole Sonic Logging Tubes

When specified in the Contract, ensure the Contractor provides access tubes in the reinforcing steel cage. The tubes must be schedule 40 steel pipe with a 2-inch inner diameter (ID) that have been manufactured in the United States of America.

B. Equipment and Methods

1. Equipment

(a) Tremies

Tremies are tubes that discharge concrete at the drilled shaft base. The use of a tremie prevents free fall of the concrete, which would result in segregation.

Ensure the following:

- The Contractor uses watertight tremies to place concrete in wet or dry holes. In a wet hole, this will prevent the water or slurry in the shaft from mixing with the concrete.

- The bottom of the tremie is able to be sealed and charged with concrete in the dry, and then opened in place at the bottom of the shaft. The Contractor usually runs a “pig” (basketball, Nerf basketball, etc.) through the tremie in advance of the concrete to keep it separated from the water or slurry in the shaft.

- The use of tremies containing aluminum parts that will come in contact with concrete will not be allowed. There is a chemical reaction between aluminum and concrete that will reduce the strength of the concrete.

- The tremie can be lowered rapidly to retard or stop the flow of concrete.

- The tremie has an inner diameter from 10 to 14 inches, clean and smooth surfaces, and a wall that prevents crimping or sharp bends.

- The top of the tremie is fitted with a hopper.

- The discharge end of the tremie must allow free radial concrete flow during placement.

(b) Concrete Pumps

Concrete pumps utilize tubes to pump concrete to the drilled shaft base. The use of a pump prevents free fall of the concrete that would result in segregation.

Ensure the following:

- Pumped concrete placement may be used in wet or dry holes.

- The Contractor uses at least 4-inch diameter discharge tubes with watertight joints. In a wet hole this will prevent the water or slurry in the shaft from mixing with the concrete.

- The discharge tube is placed at the shaft base elevation.

- For wet holes, pumps are used with a device at the end of the discharge tube to seal out water while the tube fills with concrete. If a plug is used, remove it from the hole. The Contractor usually runs a "pig" (Nerf ball, etc.) through the tube in advance of the concrete to keep it separated from the water or slurry in the shaft.

2. Excavation Methods

The Contractor will use at least one of the following methods for excavation:

(a) Dry Method

The dry construction method may be used at sites where the Resident Engineer can visually inspect the shaft before concrete placement. The dry method entails:

1. Drilling the shaft,
2. Removing accumulated water,
3. Removing loose material from the excavation,
4. Placing the reinforcing cage, and
5. Placing concrete in the shaft in dry conditions.

If caving, sloughing, or swelling conditions exist or if groundwater seepage exceeds the Contractor's ability to maintain a relatively dry shaft (less than 6 inches of water at the time of concrete placement), direct the Contractor to discontinue dry construction and use an alternative method approved by the Resident Engineer.

(b) Wet Method

The wet construction method or a casing construction method will be used for shafts that do not meet the requirements for dry construction. For the wet method, water or slurry will be used to maintain the stability of the hole while the Contractor advances the excavation to final depth, places the reinforcing cage, and concretes the shaft. The wet method involves the following work:

1. De-sanding and cleaning the slurry,

2. Final cleaning of the excavation,

3. Placing the shaft concrete with a tremie or concrete pump beginning at the shaft bottom,

4. Providing temporary surface casings to aid shaft alignment and positioning, and

5. Providing temporary surface casings to prevent sloughing of the top of the shaft excavation.

There are very detailed and specific requirements for the proper use of the slurry method. Refer to Section 516.04.C.2 of the Standard Specifications for slurry requirements. However, the introduction of a small quantity of mineral (bentonite) or polymer material into the drilled shaft for the purpose of processing the hole, does not qualify as the slurry method of excavation.

3. Casing Methods

Ensure the casing does not extend below the rock line, and extends above the surface far enough to keep the excavation clean during concrete placement. Excavation below the casing may be performed using the dry or wet method. If the top of the shaft is above ground, the shaft from the top to at least 2 feet below finished ground should be formed. If the top of the shaft is below ground, a temporary oversize surface casing should be used to control material caving into the freshly placed concrete. To provide design frictional load capacity, the Contractor should excavate into the founding stratum to the deepest length or depth shown on the Plans. Casing may be installed in accordance with one of the following methods:

(a) Temporary Casing Method

Temporary casing is necessary if caving, sloughing, or swelling conditions exist or if groundwater seepage exceeds the Contractor's ability to maintain a relatively dry shaft. Also, temporary surface casings may be useful to stabilize the top of the hole. When using temporary casing, the Contractor's operations should entail:

1. Driving or drilling the casing into the impervious formation,

2. Completing excavation,

3. Placing the reinforcing cage, and

4. Placing concrete in the shaft while removing the casing. Ensure that a minimum of 5 feet of fresh concrete is maintained above the surrounding level of water or slurry. Verify that the fresh concrete does not become mixed with the water or slurry.

Experience has shown that when temporary casing longer than 60 feet is used, that there is a significant risk of not being able to get the casing out of the ground and causing damage to the drilled shaft. There have been instances where the casing has been pulled in two while attempting to remove. While the method of construction is the choice of the Contractor, ensure that they are aware of the possible hazards. Temporary casings that are bound or fouled during shaft construction and cannot be practically removed are considered as defects in the drilled shaft and Bridge Division must be contacted before accepting.

Alternatively, the wet method may be used to advance the excavation through caving material into an impervious formation, and then set the casing.

(b) Permanent Casing Method

The permanent casing construction method will be used if shown on the Plans or where drilled shafts are in open water. For the permanent casing method, the excavation may be advanced through caving material by driving or drilling a permanent casing to the Contract required depth or into a nearly impervious formation, whichever is deepest. The Contractor should excavate to the final depth, place the reinforcing cage, and concrete the shaft. If full penetration cannot be attained during casing installation, the Contractor should excavate within the embedded portion of the casing. A pilot hole may be drilled if necessary. Ensure continuous casing from the top of the shaft to the elevation shown on the Plans. The permanent casing must be cut off at the elevation shown on the Plans and left in place after concrete placement. If the drilled shafts are in open water, casings must extend from above the water elevation into the ground to protect the shaft concrete from the water during concrete placement and curing.

(c) Double Casing Method

The double casing construction method will be used if the Contract requires or, as an alternative for the temporary casing method, in the presence of severe groundwater or unstable soil conditions.

The interior casing should have a permanent inner diameter equal to the shaft diameter shown on the Plans. The temporary exterior casing should have an inner diameter of at least 6 inches larger than the interior casing. After placing the exterior casing, the Contractor should complete the excavation as shown on the Plans. The interior casing should be set into the top of the rock line and braced at the top. The Contractor is to remove the temporary casing immediately after filling the interior casing with concrete. The Contractor may add concrete to maintain top of shaft elevation after removal of the outer casing. After the concrete initially sets, the Contractor should not adjust the interior casing position.

Experience has shown that when temporary casing longer than 60 feet is used, that there is a significant risk of not being able to get the casing out of the ground and causing damage to the drilled shaft. There have been instances where the casing has been pulled in two while attempting to remove. While the method of construction is the choice of the Contractor, ensure that they are aware of the possible hazards. Temporary casings that are bound or fouled during shaft construction and cannot be practically removed are considered as defects in the drilled shaft and Bridge Division must be contacted before accepting.

C. Construction Operations

1. Drilling Operation

(a) Tolerances

Ensure the drilled shaft is excavated within the following tolerances:

- The center of the top of the shaft is within 3 inches horizontally and 1 inch vertically of the position shown on the Plans.

- The vertical shaft alignment does not vary by more than 1 percent of shaft depth (if the shaft is 50 feet long, it must be within 0.5 feet (6 inches) of being vertical).

- The bottom of the shaft must be relatively flat. The shaft bottom must be normal to the axis of the shaft within 5 percent of the shaft diameter (if the shaft is 60 inches in diameter, the bottom must be within 3 inches of being horizontal).

- The shaft diameter must be no more than 1 inches smaller than the diameter required by the Plans.

Verify that the Contractor checks the dimensions and alignment of the drilled shaft excavations and that all of the measurements are within the required tolerances. If something is found to be out of tolerance, drilling operations must be suspended and corrective measures taken. Measure and document the final shaft depth/elevation after final cleaning.

If the sidewall of the hole softens due to excavation methods, swells due to delays in concreting, or degrades due to slurry cake buildup, the Contractor must over-ream the sidewall from 0.5 to 3 inches to sound material.

(b) Excavated Material

The Inspector and the Contractor should continually monitor the characteristics of the excavated material to ensure it is consistent with the boring logs. If the load bearing material does not satisfy Plan requirements (i.e. is a different material or is encountered at a lower elevation than shown on the boring logs), the Contractor must continue to excavate below the elevation shown on the Plans. Soil samples or rock cores must be taken as shown on the Plans to determine the character of the material directly below the shaft excavation. The Contractor must immediately notify the Resident Engineer of deviations in subsurface conditions that may change the shaft depth.

(c) Obstructions

The Department defines an obstruction as unexpected manmade materials through which excavation cannot advance using normal drilling methods and equipment. The Department does not consider removal of tools which are lost in the excavation to be an obstruction. Removal of naturally-occurring material, regardless of difficulty or removal method, is not considered an obstruction. Examples of obstructions could include old car body, old foundation that was not depicted in the Plans, riprap embedded beneath the surface, etc.

The Contractor must remove obstructions encountered during excavation, and is required to notify the Resident Engineer, in advance, of the proposed obstruction removal method. Once the Contractor has advised the Department that an obstruction has been encountered, the Inspector is to document the additional equipment and time required to advance the excavation, and document the material removed. Compensation for the removal of obstructions will be in accordance with Section 104.03 of the Standard Specifications with the Contractor submitting a cost breakdown for the additional work. Blasting methods should not be used, but if the Contractor does want to use blasting, they must request it in writing for approval from the Bridge Division.

(d) Final Cleaning

Immediately before placing concrete, the Contractor must clean the hole so that 50 percent of the hole has less than 0.5 inches of sediment in the bottom. Ensure the remaining 50 percent of the hole has no greater than 1.5 inches of sediment or debris. For dry holes, the water depth must be reduced to 6 inches or less before placing concrete.

Once the Contractor completes the drilling operations, it is their responsibility to maintain the integrity of the hole until such time as the reinforcing steel and concrete are placed. Verify that a protective covering is installed over the drilled shaft to prevent persons and materials from falling into the hole.

2. Reinforcing Steel Cages

(a) General

Ensure the following after the excavation has been approved:

1. The steel cage has the proper bar size, spacing, and fastening.

2. The cage height and diameter are in conformance.

3. The lap splices are the specified length and are properly tied together using wire.

4. Spacing devices (concrete rollers or sleds) are placed as follows:

    a. At fifth points around the cage perimeter or one per 12 inches of shaft diameter.

    b. At intervals no greater than 10 feet along the length of the cage.

    c. Within 18 inches of the top and bottom of the shaft.

    d. Are equivalent to the shaft concrete in quality and durability.

    e. Concrete rollers must be used unless otherwise approved by the Bridge Division. The use of plastic rollers, metal chairs, etc. will not be allowed. Concrete sleds are acceptable in lieu of the rollers when casing is used down to the rock line.

5. The reinforcing steel cage is placed as a single unit into the hole before concrete placement. The cage must be tied and supported concentrically to prevent racking and distortion during lifting and placement into the excavated hole.

6. A support system is provided so that the cage does not sit on the bottom nor lean against the wall of the hole.

7. If the concrete is not placed immediately after the cage installation, the cage is removed and the integrity of the excavated area is verified to ensure loose material is removed from the bottom of the hole.

8. Additional reinforcing steel will be necessary if conditions require shafts to be longer than shown on the Plans. If it is necessary to extend the length of the shaft, contact Bridge Division for the proper splice length. For example, a No. 11 bar could require as much as 12 feet of lap depending on the location of the splice, bar spacing, epoxy coating, etc.

During concrete placement, positive support must be provided to the top of the reinforcing steel cage. Ensure that the top of the reinforcing steel cage is no more than 6 inches above or 3 inches below the planned elevation. Require corrective action if the reinforcing steel cage is not maintained in that position. If problems occur, do not allow the construction of additional shafts until the method of reinforcing steel cage support has been approved by the Resident Engineer.

(b) Access Tubes for Crosshole Sonic Logging

Crosshole Sonic Logging (CSL) testing is for the purpose of determining if the drilled shaft has anomalies or defects. Steel tubes must be located within the reinforcing cage to provide access for this testing. This work will be specified in the Contract with the pay item 516(C) for Crosshole Sonic Logging and 516(D) CSL Access Tubes. Refer to Section 516.04.C(4)(b) of the Standard Specifications for the requirements associated with this work.

3. Concrete Placement

(a) Inspection Prior to Concrete Placement

Before allowing the Contractor to begin concrete placement operations, ensure the following:

1. The Contractor has cleaned the hole so that 50 percent of the hole has less than 0.5 inches of sediment in the bottom, and the remaining 50 percent of the hole has no greater than 1.5 inches of sediment or debris.

2. For dry holes, the water depth must be reduced to 6 inches or less before placing concrete.

3. For wet holes, allow water to seek its natural hydraulic head.

4. The reinforcing steel cage is placed as a single unit into the hole.

5. A support system is provided so that the cage does not sit on the bottom nor lean against the wall of the hole.

6. Tremie or concrete pumps provided are of the correct size and have a clean and smooth interior.

7. Check the concrete delivery ticket to ensure that the proper class of concrete and mix design is being provided.

(b) Inspection During Concrete Placement

The Inspector must ensure the following:

1. For wet holes, the Contractor runs a “pig” through the tremie in advance of the concrete to keep it separated from the water or slurry in the shaft.

2. The discharge end of the tremie or concrete pump is placed at the bottom of shaft.

3. The discharge end of the tremie or pump is kept immersed at least 5 feet below the surface of the fluid concrete. A positive head of concrete in the tremie or pump must be maintained during concrete placement. If the discharge end is removed from the fluid concrete column during the concrete placement and concrete is discharged above the rising concrete surface into displaced water or slurry, the reinforcing cage and concrete must be removed and the shaft reconstructed. (link to Calvin’s worksheet)

4. Concreting in the shaft and removal of the temporary casing is completed within 2 hours of beginning concrete placement. Inspector must document the time of beginning and ending.

5. Monitor and document the depth of the concrete in the hole and the quantity of concrete placed to help determine the possibility of voids around or intrusions into the drilled shaft. (link to Calvin’s worksheet)

6. Concrete is placed in the hole until quality concrete reaches the top of the shaft. Overflow of concrete in shafts is to be

continued until uncontaminated concrete is evident (usually for a dry shaft, overflow the top with 1 foot of concrete, and for a wet shaft, overflow the top with 5 feet of concrete).

(c) After Concrete Placement

The Inspector must ensure the following:

1. Before initial concrete sets, the top 10 feet of the shaft is consolidated using approved vibratory equipment.

2. The top of the reinforcing steel cage for the drilled shaft is no more than 6 inches above or 3 inches below the planned elevation and is in the proper horizontal alignment.

3. The reinforcing steel cage for the subsequent concrete placement (column or cap) is installed and properly aligned before the initial set of the drilled shaft concrete. Provide adequate support of this cage during curing of the drilled shaft concrete.

4. The center of the top of the shaft is within 3 inches horizontally and 1 inch vertically of the position shown on the Plans.

5. The exposed concrete surfaces are cured in accordance with Section 509 of the Standard Specifications.

D. Safety and Environmental Considerations

Ensure that the Contractor complies with its plan to protect workers and traffic during construction. This includes:

- Providing fall protection for workers,
- Preventing tools, material etc. from falling on traffic beneath, and
- Properly disposing of excavated material, slurry and excess concrete.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location or Structure Number and the type of work being performed (i.e. Bridge 'A' - Pier #1 - Left Shaft - Excavating for drilled shaft).
-
- Any obstructions encountered and method of removal.

- The depth of the drilled shaft into the bearing material (rock, shale, etc.).
- If a pre-pour inspection occurred and who was in attendance and list any corrective actions identified.
- Linear foot of drilled shaft and classification of concrete placed.
- Any conditions requiring corrective actions, location of correction as well as individual contacted and their recommendations

(link to Calvin's form)

2. Measurement and Payment

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the change order (i.e. description, explanation, attachment, etc.).

(a) Linear Foot Unit of Measure Pay Items

Measure and calculate the quantity of Drilled Shafts, Trial Drilled Shafts and CSL Access Tubes complete in place utilizing drawings, spreadsheets, hand calculations, etc.

Measure and document the final drilled shaft depth/elevation after final cleaning. Furnish the bottom and top elevations of the drilled shaft and the foundation material (rock).

Documentation of this item will be performed within the SiteManager / Daily Work Reports / Work Items tab.

1. Select the appropriate pay item from the list of contract pay items.

2. In the appropriate field, enter the descriptive location (i.e. Bridge 'A' - Pier #1 - Left Shaft) or the station and location.

3. In the Placed Quantity field enter the linear foot of Drilled Shaft or CSL Access Tubes complete in place.

(b) Each Unit of Measure Pay Items

Documentation of these items will be performed within the SiteManager / Daily Work Reports / Work Items tab.

1. Select the appropriate pay item from the list of contract pay items.

2. In the appropriate field, enter the descriptive location (i.e. Bridge 'A' - Pier #1 - Left Shaft) or the station and location.

3. In the Placed Quantity field enter the number of Crosshole Sonic Logging complete in place. This quantity will either be as shown on the plans or as actual counted in place, if the item is not specified as Pay Plan Quantity.

In the SiteManager / Daily Work Reports / Work Items tab / Remarks Bubble, provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown.

(c) Documentation Procedures for the Drilled Shaft Foundations Pay Items

1. Drilled Shafts (LF) - This pay item will be documented utilizing the DWR Work Items tab.

2. Trial Drilled Shafts (LF) - This pay item will be documented utilizing the DWR Work Items tab.

3. Crosshole Sonic Logging (EA) - This pay item will be documented utilizing the DWR Work Items tab.

4. CSL Access Tubes (LF) - This pay item will be documented utilizing the DWR Work Items tab.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

516.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

Ensure that the 28 day concrete compressive strength requirements have been satisfied in accordance with Section 509 of this Manual.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

Verify that the projecting reinforcing steel is in the correct location and properly cleaned of mortar.

When nondestructive testing of drilled shafts is required, ensure the testing is performed in accordance with Section 516.04.C.6 of the Standard Specifications or any applicable special provisions, and is completed prior to placing concrete for columns.

CHECKLIST – DRILLED SHAFT FOUNDATIONS

Part 1: Preconstruction

Issue	Yes	No	N/A	Comments	Initials
Underground utility locations have been staked and all known conflicts have been resolved.					
Overhead utilities will not conflict with the drilled shaft construction operations and equipment.					
Contractor has submitted an acceptable installation plan.					

Part 2: During Construction

Issue	Yes	No	N/A	Comments	Initials
Drilled shaft is excavated within the specified tolerances.					
No obstructions (unexpected manmade materials) are encountered during excavation.					
Load bearing material satisfies Plan requirements (matches boring information).					
Contractor maintains the integrity of the hole.					
A protective cover is installed over the drilled shaft to prevent persons and objects from entering the hole.					
The bottom of the shaft excavation is clear of any loose material prior to placement of reinforcing steel and concrete. (50 percent of the hole has less than 0.5 inches of sediment in the bottom, and the remaining 50 percent of the hole has no greater than 1.5 inches of sediment or debris)					
For dry holes, the water depth is 6 inches or less before placing concrete.					
The steel cage meets specified requirements (e.g., bar size, spacing, fastening).					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Steel cage is placed as a single unit into hole before concrete placement.					
The top of the reinforcing steel cage is no more than 6 inches above or 3 inches below the planned elevation and is in the proper horizontal alignment.					
The proper class of concrete and mix design is provided.					
Contractor completes concreting in the shaft and removal of the temporary casing within 2 hours of beginning concrete placement.					
A positive head of concrete in the tremie or pump is maintained during concrete placement.					
Concrete is placed in the hole until quality concrete reaches the top of the shaft.					
Before initial concrete sets, the top 10 feet of the shaft is consolidated using approved vibratory equipment.					
Contractor properly disposes of excess concrete and excavation waste material.					
Contractor properly disposes of slurry, if used.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Drilled shafts have been drilled at the designated location, and to the designated depth and diameter.					
Concrete is placed and finished to the elevations shown on the Plans.					
Projecting reinforcing steel is in the correct location and properly cleaned of mortar.					

SECTION 517 – POST-TENSIONING

517.01 GENERAL

This work consists of stressing concrete by furnishing, placing, and tensioning post-tensioning steel in accordance with details shown in the Contract and as specified.

For the purposes of this Manual, this topic will not be discussed in great detail. Oklahoma does very little post-tensioning, and this is a highly technical operation subject to frequent changes in the methods utilized. Great care should be taken to follow the specifications and any special provisions provided for your particular project. Feel free to contact the Bridge Division and the Materials Division for any assistance in this work.

517.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- The post-tensioning design, anchorage system and post-tensioning system must be provided by an approved supplier. This must be provided to Bridge Division for approval. There should be no substitutions to an approved system.
- Sealing of the duct system and pressure testing.
- The importance of protecting the strand. Even a small amount of rust can reduce the life span of the bridge.
- The importance of using an approved and properly mixed grout. This is the only protection the strand has from corrosion.
- At least 6 weeks before scheduled grouting operations, a grouting operations plan must be submitted to the Resident Engineer for review by the Materials Division and approval by the Bridge Division.
- Scheduling of placing the system ducts, tendons and grouting. Grouting operations must be completed within 7 calendar days of post-tensioning steel installation in the duct. If it is not completed in 7 days, the Resident Engineer will stop the work and instruct the removal of tendons.

B. Acceptance of Materials

For the purposes of this Manual, post-tensioning will not be discussed in great detail. Oklahoma does very little post-tensioning, and this is a highly technical operation, subject to frequent changes in the methods and materials used. Great care should be taken to follow the specifications and any special provisions provided for your particular project.

Contact the Bridge Division and the Materials Division for the prior approval of the materials to be incorporated in this work.

C. Preparatory Work and Contractor Work Plans

The Contractor must submit shop drawings and work plans to the Bridge Division in accordance with Section 517.04.B and Section 105.02 of the Standard Specifications. The Contractor's work plans and shop drawings should detail the following:

- Post-tensioning systems,
- Tendon geometry and locations shown on the Plans in accordance with the limitations of the approved post-tensioning system,
- Inlets,
- Outlets,
- High point outlet inspection,
- Anchorage inspection,
- Permanent grout caps,
- Protection system materials,
- Application limits, and
- Method and spacing of duct supports.

At least 6 weeks before scheduled grouting operations, the Contractor must submit a grouting operations plan to the Resident Engineer for review by the Materials Division and approval by the Bridge Division. Review and approval of the plan must be obtained in writing before permanent structure grouting begins. Ensure the plan addresses the following:

- Grouting crew and supervisor names and proof of training,
- Grouting certification,
- Material types, quantities, and brands for grouting including certifications,
- Equipment types, capacity in relation to demand and working condition, back-up equipment, and spare parts,
- General grouting procedure,
- Duct pressure test and repair procedures,
- Method to control the flow rate in ducts,
- Theoretical grout volume calculations,
- Mixing and pumping procedures,
- Grouting direction,
- Sequence of inlet and outlet pipe,
- Procedures for handling blockages, and
- Procedures for post-grouting repair.

D. Safety and Environmental Issues

Do not stand around or behind the tendon during the stressing operations. If a strand or tendon breaks or comes loose this could result in death or dismemberment.

Ensure that the Contractor has a plan to collect and properly dispose of any excess grout.

517.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

For the purposes of this Manual, post-tensioning will not be discussed in great detail. Oklahoma does very little post-tensioning, and this is a highly technical operation, subject to frequent changes in the methods and materials used. Great care should be taken to follow the specifications and any special provisions provided for your particular project.

Ensure that the materials approved for use in this work are used by the Contractor. If any differences are discovered, contact the Bridge Division and the Materials Division for assistance.

B. Equipment and Methods

For the various requirements of the stressing and grouting equipment refer to Section 517.03 of the Standard Specifications.

C. Construction Operations

For the purposes of this Manual, the topic of post-tensioning will not be discussed in great detail. Oklahoma does very little post-tensioning, and this is a highly technical operation subject to frequent changes in the methods utilized. Great care should be taken to follow the requirements of Section 517.04 of the Standard Specifications, any special provisions, and plan notes provided for your particular project. Feel free to contact the Bridge Division and the Materials Division for any assistance in this work.

There are detailed testing and reporting requirements for the duct placement, tendon tensioning and grouting operations.

D. Safety and Environmental Considerations

Do not stand around or behind the tendon during the stressing operations. If a strand or tendon breaks or comes loose this could result in death or dismemberment.

Ensure that the Contractor collects and properly disposes of any excess grout.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location and description of work being performed (i.e. Bridge ‘A’, Span # 1, Duct #3, Stressing tendons)

- Conditions affecting the progress of or delaying prosecution of the work, equipment break downs, etc.

- Discussion of project prosecution with the Contractor that are of an unusual nature and any specific recommendations or instructions to the Contractor

- Weather Conditions during application and curing

- Any conditions requiring corrective actions, and individual contacted and their recommendations

- Document who performs the corrective actions

2. Measurement and Payment

Documentation of these Lump Sum items will be performed within the SiteManager / Daily Work Reports / Work Items tab.

- Select the appropriate pay item from the list of contract pay items.

- In the appropriate field, enter the descriptive location (i.e. Bridge ‘A’ - Span #1 - Duct #3).

- In the Placed Quantity field, enter an estimated percentage of the lump sum item completed, ensuring that the total quantities to date does not exceed 1.00 Lump Sum.

In the SiteManager / Daily Work Reports / Work Items tab / Remarks Bubble, provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown.

Ensure the contractor submits two copies of the test report for the “In Place Friction Test” within 2 weeks of installation of the test tendon.

Within 72 hr of the completion of each grouting operation, the contractor must sign and submit a grouting report to the Resident Engineer for review by the Bridge Division and the Materials Division with subsequent approval by the Resident Engineer.

The contractor must report the theoretical quantity of grout compared to the quantity of grout used to fill the duct, and notify the Resident Engineer, the Bridge Division and the Materials Division of any shortages or overages.

The following information must be included in this report:

- Tendon identification,
- Date grouted,
- Number of days from tendon installation to grouting,
- Grout type,
- Injection end and applied grouting pressure,
- Ratio of actual to theoretical grout quantity, and
- Summary of problems and corrective action.

The Resident Engineer should withhold a percentage of the total payment for these items (up to 20% for each item) until the contractor has provided the documentation referenced in section 517.04 of the standard specifications.

517.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

For the purposes of this Manual, post-tensioning will not be discussed in great detail. Oklahoma does very little post-tensioning, and this is a highly technical operation, subject to frequent changes in the methods and materials used. Great care should be taken to follow the specifications and any special provisions provided for your particular project.

Contact the Bridge Division and the Materials Division for assistance with the specialized post-construction testing that will be necessary to ensure that the work meets the specifications.

B. Audit Requirements

Ensure the project file contains the documentation referenced in section 517.04 of the standard specifications which includes the following:

- Tendon Modulus of Elasticity Test Report, if the Contract requires. For each increment and decrement record the following:
  - Gauge pressure
  - Elongations
  - Load cell force
  - Revisions made if the bench test varies from the modulus of elasticity on the shop drawings or working drawings by more than 1 percent
  - The test apparatus and methods used

    - Signature of the Engineer witnessing the testing
- In Place Friction Test Report
    - The test apparatus and methods used
    - Signature of the Engineer witnessing the testing
- Grouting Report
    - The theoretical quantity of grout compared to the quantity of grout used to fill each duct
    - Tendon identification
    - Date grouted
    - Number of days from tendon installation to grouting
    - Grout type
    - Injection end and applied grouting pressure
    - Ratio of actual to theoretical grout quantity
    - Summary of problems and corrective action.

The Resident Engineer should withhold a percentage of the total payment for these items (up to 20% for each item) until the contractor has provided the documentation referenced in section 517.04 of the standard specifications

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Payment for this item must equal 1.00 Lump Sum. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

To ensure the longevity of the tendons, the grouting operation must have been completed in accordance with Section 517.04.I of the Standard Specifications. This specification requires post-grouting inspections to find and repair all voids and defects within the duct system. This is extremely important and must be strictly adhered to.

Ensure proper protection of the anchorage end caps until the concrete has cured. Very detailed requirements are indicated in Section 517.04.J of the Standard Specifications, any special provisions and plan notes provided for your particular project.

CHECKLIST – POST-TENSIONING

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Bridge Division approves the proposed supplier of the post-tensioning system.					
Material Division has reviewed, and Bridge Division has approved, the Contractor's grouting operations plan.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Contractor takes proper safety precautions.					
Grouting operations are completed within 7 calendar days of post-tensioning steel installation in the duct.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Contractor collects and properly disposes of excess grout.					
Post-grouting inspection is performed in accordance with Section 517.04.I.					
Anchorage end caps are kept protected until the concrete has cured.					

SECTION 520 – STRUCTURAL CONCRETE REPAIR BY SEALING AND INJECTION

520.01 GENERAL

This work consists of restoring the structural integrity of portland cement concrete (PCC) structures by injecting and sealing cracks, delaminations, and hollow planes with an epoxy resin system.

520.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Epoxy resin system must be a Type D epoxy in accordance with Section 701.13 of the Standard Specifications.
- Compliance with the manufacturer's recommendations regarding temperature and curing requirements for the epoxy resin material.
- Crack size and potential for crack preparation.

B. Acceptance of Materials

Verify that the epoxy resin system proposed by the Contractor is an approved system shown on the Approved Products List (APL) [add link]. If the proposed epoxy resin system is not on the APL, contact Materials Division.

C. Preparatory Work and Contractor Work Plans

Ensure the surfaces adjacent to cracks are cleaned of efflorescence (see Figure 520:1), deteriorated concrete, and other surface debris. The interior surfaces of the cracks must be cleaned by vacuuming, flushing, sawing, or other methods approved by the Inspector.

Verify that the cracks are widened to 0.25 inches at the concrete surface (NOTE: Cracks in prestressed concrete beams should NOT be widened). A quick-setting sealant must be applied around the injection ports to prevent epoxy resin loss. Ensure that defacement of the concrete surface is prevented. The Resident Engineer may approve the use of a clear plastic plate with injection ports attached to facilitate placement of the epoxy resin in the crack.

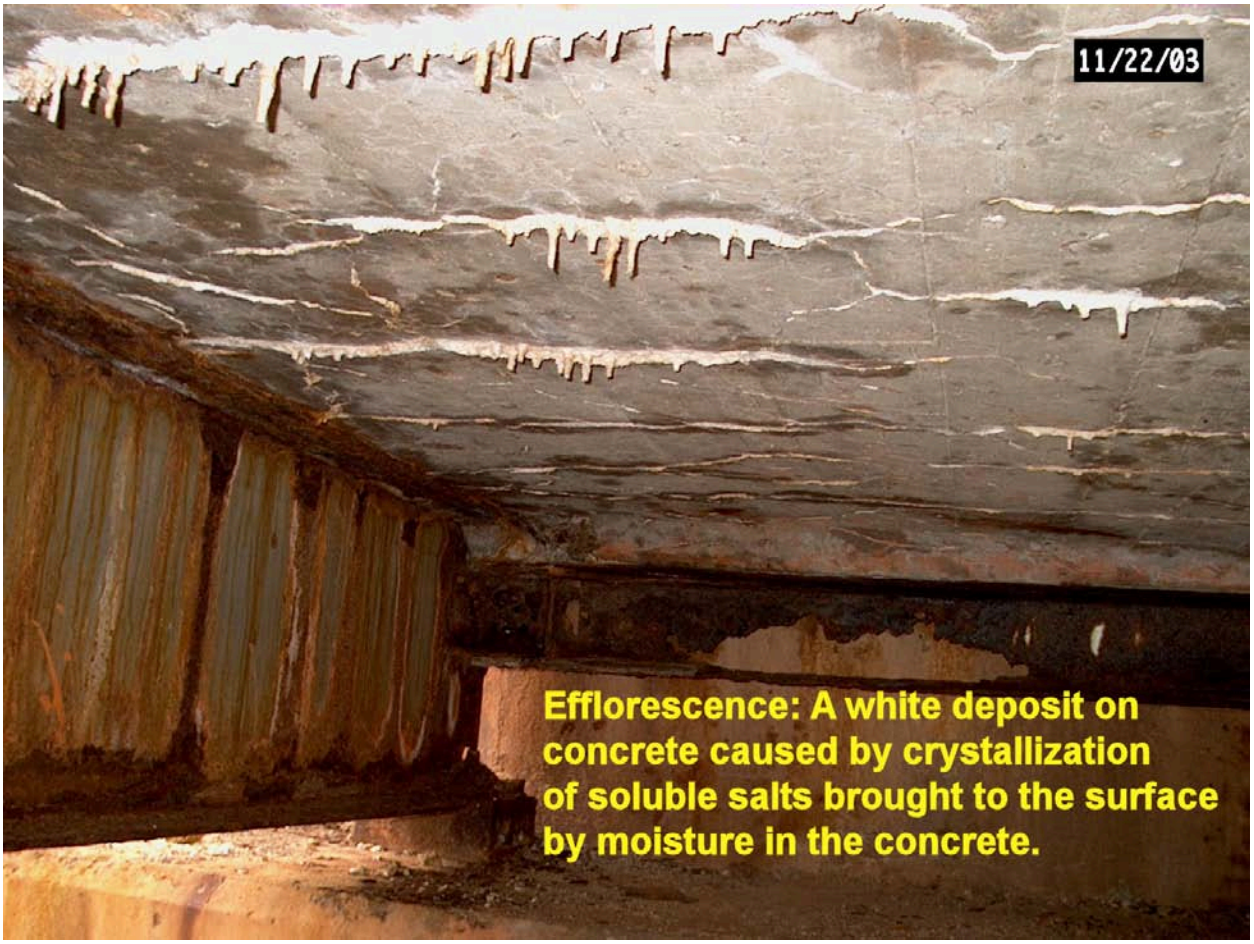


Figure 520:1. Photo. Efflorescence

D. Safety and Environmental Issues

Care should be taken to prevent eye or skin contact with the sealants and epoxy resins. Comply with all Material Safety Data Sheet (MSDS) requirements. Personal protective equipment must be used by the personnel performing the work, especially in confined locations such as the interior of box girders.

520.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

Verify that the epoxy resin system proposed by the contractor is an approved system shown on the Approved Products List (APL) [add link]. If the proposed epoxy resin system is not on the APL, contact Materials Division.

B. Equipment and Methods

Ensure that the Contractor provides a pressure pot, hand pump, caulking device, injection machine, or other device to inject the epoxy resin.

Special pressure fittings on the injector must be provided to prevent leaks when injecting the epoxy resin through the 0.25-inch holes in the pressure plates.

The Contractor must provide injection ports such as tubes, fittings, or pressure plates for the epoxy resin system that can withstand injection pressures of 60 psi or more. A plug to seal each injection port will be required.

Verify that the injection ports are drilled using equipment with a vacuum system to prevent dust from compacting into the cracks and laminations.

C. Construction Operations

1. Epoxy Resin Injection

Ensure the injection ports are spaced so that the epoxy resin can travel between them. The injection operation must begin at the lowest port. Pumping should continue until the epoxy resin is sighted at the port directly above or adjacent to the injection port.

When the epoxy resin is sighted at an adjacent port, the Contractor should move the nozzle to the port showing epoxy resin, and plug the previous injection port. The Contractor should continue this procedure to completely fill the crack. On wide cracks where travel of the epoxy resin between ports is rapid, the Department will allow simultaneous pumping of two or more ports.

2. Leveling of Surface Seal

After the resin cures, ensure that the surfaces are ground until flush with the concrete surface. After leveling of the surface seal, inspect the crack for voids not filled by the epoxy resin.

D. Safety and Environmental Considerations

Care should be taken to prevent eye or skin contact with the sealants and epoxy resins. Comply with all Material Safety Data Sheet (MSDS) requirements. Personal protective equipment must be used by the personnel performing the work, especially in confined locations such as the interior of box girders.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location and description of work being performed (i.e. Bridge ‘A’, Pier #1, Pier Cap, Cleaning and Sealing Cracks)
- Conditions affecting the progress of or delaying prosecution of the work, equipment break downs, etc.
- Discussion of project prosecution with the Contractor that are of an unusual nature and any specific recommendations or instructions to the Contractor
- Weather Conditions during application and curing
- Any conditions requiring corrective actions, and individual contacted and their recommendations
- Document who performs the corrective actions

2. Measurement and Payment

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the change order (i.e. description, explanation, attachment, etc.).

(a) Linear Foot Unit of Measure Pay Items

Measure and calculate the quantity of Crack Preparation complete in place utilizing drawings, spreadsheets, hand calculations, etc.

Documentation of these items will be performed within the SiteManager / Daily Work Reports / Work Items tab.

1. Select the appropriate pay item from the list of contract pay items.
2. In the appropriate field, enter the descriptive location (i.e. Bridge ‘A’ – Pier #1 – Pier Cap) or the station and location.
3. In the Placed Quantity field enter the linear foot of crack prepared for injection complete in place.

(b) Gallon Unit of Measure Pay Items

Determine the quantity of Epoxy Resin placed utilizing the supplier's invoice and paying to the nearest whole container (i.e. five gallon bucket) of epoxy injected.

Documentation of these items will be performed within the SiteManager / Daily Work Reports / Work Items tab.

1. Select the appropriate pay item from the list of contract pay items.

2. In the appropriate field, enter either a descriptive location (i.e. Bridge 'A' – Pier #1 – Pier Cap) or the station and location.

3. In the Placed Quantity field, enter the quantity of epoxy injected complete in place.

(c) Documentation Procedures for the Sealing and Injection Pay Items

1. Preparation of Cracks, Above Water (LF) - This pay item will be documented utilizing the DWR Work Items tab.

2. Preparation of Cracks, Above Water (LF) - This pay item will be documented utilizing the DWR Work Items tab.

3. Epoxy Resin, Above Water (GAL) - This pay item will be documented utilizing the DWR Work Items tab.

4. Epoxy Resin, Below Water (GAL) - This pay item will be documented utilizing the DWR Work Items tab.

Provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown.

520.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

None required.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work

Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order (i.e. description, explanation, attachment, etc.).

For Preparation of Cracks, the quantities will be measured and calculated utilizing drawings, spreadsheets, hand calculations, etc. These calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report.

For Epoxy Resin, determine the quantity of Epoxy Resin placed utilizing the supplier's invoice and paying to the nearest whole container (i.e. five gallon bucket) of epoxy injected.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

Verify that the repaired areas are cleaned up daily. This includes removal of all injection ports from the crack, and picking up trash and debris from the Project Site.

CHECKLIST – STRUCTURAL CONCRETE REPAIR BY SEALING AND INJECTION

Part 1: Preconstruction

Issue	Yes	No	N/A	Comments	Initials
Surfaces adjacent to cracks are cleaned of efflorescence, deteriorated concrete, and other surface debris.					

Part 2: During Construction

Issue	Yes	No	N/A	Comments	Initials
Contractor is using the specified epoxy resin system.					
Cracks are widened to 0.25 inches at the concrete surface.					
Contractor's personal wear personal protective equipment when performing the work.					
Contractor is complying with the manufacturer's recommendations regarding temperature and curing requirements for the epoxy resin material.					

Part 3: Post-Construction

Issue	Yes	No	N/A	Comments	Initials
The resin-filled crack is flush with the concrete surface.					

SECTION 521 – PNEUMATICALLY APPLIED MORTAR

521.01 GENERAL

This work consists of providing and placing pneumatically applied mortar to:

Construct portions of structures,
Repair concrete structures,
Texture concrete surfaces,
Encase structural steel members,
Line ditches and channels, and
Pave slopes.

This work also includes preparing surfaces to receive mortar, and providing and placing reinforcing steel and anchors for reinforcement.

The mortar is applied using either a dry or wet mix method. The dry mix method (gunite) involves placing the dry ingredients into a hopper and then conveying them pneumatically through a hose to the nozzle. The nozzleman who holds the nozzle then controls the addition of water at the nozzle. The water and the dry mixture is not completely mixed, but is completed as the mixture impinges on the receiving surface. This requires a highly skilled nozzleman, especially in the case of thick or heavily reinforced sections. Advantages of the dry mix process are that the water content can be controlled and adjusted instantaneously by the nozzleman, which allows the material to be placed more effectively in overhead and vertical applications without the use of accelerators. The dry mix process also has advantages in repair applications when it is necessary to stop frequently, as the dry material is easily discharged from the hose.

The wet mix method (shotcrete) involves pumping of a previously prepared concrete, typically ready-mixed concrete, to the nozzle. Compressed air is introduced at the nozzle to impel the mixture onto the receiving surface. The wet-gun procedure generally produces less rebound, waste (when material falls to the floor), and dusts compared to the dry-mix procedure. The greatest advantage of the wet-mix process is that larger volumes can be placed in less time.

521.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- The method of surface preparation required by the Project Plans.
- Contractor’s mix design and source of materials.
- Contractor’s method of placement (wet or dry) and equipment to be used.
- Contractor’s proposed schedule for work and any restrictions detailed in the Plans and Contract.

- Proximity of work to traffic and method of protection for the public and adjacent structures.

In addition, the Resident Engineer may request that the Contractor submit their employee credentials to perform this type of work (i.e. the experience of the nozzleman using the dry mix method).

The Resident Engineer may also request pullout testing be performed by the Contractor on anchor or driven studs.

B. Acceptance of Materials

1. Mortar Mix Design

For the mortar, the contractor will submit their proposed mix design before beginning the work. The Resident Engineer will approve the proposed mix design in accordance with the following:

- A cement-to-aggregate ratio based on dry loose volumes
- At least one-part cement to three and one-half parts aggregate for concrete structures and steel members, or at least one-part cement to five parts aggregate for ditches, channels, and slopes
- Minimal water content to provide workability of the mix. Adjust the water content so the mix adheres and will not sag or fall from vertical surfaces, or separate in horizontal surfaces.
- The combination of aggregates in the mortar may not contain more than 30% coarse aggregate.
- Provide coarse aggregate in accordance with section 701.06 of the standard specifications, with gradation in accordance with AASHTO M 43, No. 8 or No. 89.

As soon as practical, the Residency will obtain sufficient samples of aggregates to be utilized and perform applicable tests on these materials.

2. Sources of Materials

The contractor will submit their proposed sources of materials. The Residency will verify that the proposed sources of materials are on the Approved Products List (APL). If a proposed source is not on the APL, the Resident must contact Materials Division immediately. Verify the APL for the following:

- Mortar:
  - Portland cement (specify type).
  - Coarse aggregate.
  - Fine aggregate (natural or blended).
- Curing Materials
- Concrete Surface Finish Material

The Residency will verify that the proposed water source is from an approved ODEQ public water source. If not, the contractor must provide verification that the water source complies with the requirements of section 701.04 of the standard specifications.

When used and as soon as practical, the Residency will obtain sufficient samples of welded wire fabric (2’ x 2’ sample for each heat number) and anchor studs (3 studs for each heat number). Submit samples to Materials Division for testing.

C. Preparatory Work and Contractor Work Plans

The surface against which the pneumatically applied mortar will be placed (e.g., earth, forms, concrete or rock) will dictate what the Inspector should look for with regard to proper surface preparation. The objective is to identify conditions that would prevent a proper bond between the mortar and the existing surface.

1. Earth Surfaces

If the Contractor will be placing pneumatically applied mortar (shotcrete, gunite or other approved system) against earth, ensure the following:

- The area is graded as required in the Plans;
- The area is compacted with moisture to provide a firm foundation and to prevent the mortar from losing moisture;
- There is no standing water on the surface prior to placement;
- Joints, side forms, headers, and shooting strips for backing or paneling are provided as required in the Plans; and
- Ground or gauging wires are installed to establish thicknesses, surface planes, and finish lines.

2. Concrete or Rock

If the Contractor is placing mortar against concrete or rock, ensure the following:

- Deteriorated and loose material is removed with pneumatic or hand tools.
- The edges along the perimeter of the repair area are cut square or slightly undercut at least 1 inch deep. This will prevent a feathered edge where the mortar could debond or come loose.
- The surface is sandblasted to clean rust from exposed steel and to produce a clean, rough surface.
- The surface is kept wet for at least 1 hour.
- The surface is allowed to dry just before the mortar is applied.

3. Forms

If placing mortar against forms, ensure that the Contractor provide forms in accordance with Section 502 of the Standard Specifications.

D. Safety and Environmental Issues

Ensure the Contractor is aware that they will not be allowed to dispose of excess mortar in waterways, as discussed in the following video.

Discuss with the Contractor its plan to protect workers and traffic during construction. This plan should address the following:

- Providing fall protection for workers,
- Preventing tools, material etc. from falling on traffic beneath,
- Providing traffic control during construction,
- Proximity of work to traffic and method of protection for the public and adjacent structures, and
- Ensuring personal protection equipment is worn by Contractor personnel while applying the mortar.

521.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

1. Mortar Mix Design

Ensure the Resident Engineer has approved the mortar mix design in accordance with section 521.02.B.1 of this manual. Any changes to the approved mortar mix design, including substitution of material sources, must be approved by the Resident Engineer.

2. Materials

Ensure the contractor has submitted their proposed sources of materials. The Residency will verify that no changes were made from the proposed sources of materials and that they are still on the APL. If a proposed source is not on the APL, the Resident must contact Materials Division immediately.

Document or perform applicable tests as follows:

- Mortar:
    - Portland cement (specify type) [Document in Template AM5001].
    - Coarse aggregate – sample and test for appropriate gradation AASHTO T11 and T27 [Document in Template T27].
    - Fine aggregate (natural or blended) – AASHTO T11 and T27 [Document in Template T27].
- Curing Materials [Document in Template AM5001].

- Concrete Surface Finish Material [Document in Template AM5001].

The Residency will verify that the proposed water source is from an approved ODEQ public water source. If not, the contractor must provide verification that the water source complies with the requirements of section 701.04 of the standard specifications.

The Residency will sample and test fresh mortar, when required by the plans, for Air Content and Compressive Strength.

When used, ensure sufficient samples of welded wire fabric (2' x 2' sample for each heat number) and anchor studs (3 studs for each heat number) were submitted to Materials Division for testing.

B. Equipment and Methods

1. Studs

If placing mortar against existing concrete or rock, the Contractor must provide anchor studs or driven studs in compliance with the following requirements:

(a) Anchor Studs

- Anchor studs should be at least 0.25-inch diameter expansion hook bolts.
- Anchor studs are placed in drilled holes to support reinforcing wire fabric or bars.
- Each individual bolt must resist a pullout force of 150 lbf.
- The Resident Engineer may request pullout testing be performed by the Contractor.

(b) Driven Steel Studs

- The Contractor must obtain the Resident Engineer's approval before using driven steel studs.
- Studs must have a diameter of at least ⅛ inch and a length of at least 2 inches.
- The Contractor should provide equipment that uses an explosive as the driving force and that can insert the stud or pin to a depth capable of sustaining the 150 lbf pullout force without damaging the concrete or rock.

- The Resident Engineer may request pullout testing be performed by the Contractor.

2. Mixing Equipment

The Contractor must use a paddle or drum-type mixer designed for pneumatic application to uniformly mix the materials before charging the placing equipment. Transit mix equipment and methods may be used for the wet mix process.

3. Pneumatic Application Equipment

The mortar must be applied with pneumatic equipment that sprays the mix onto the surface at a velocity high enough to produce a compacted, homogeneous mass. The air compressor and delivery hose lines used must provide a pressure of at least 35 psi for 1-inch nozzles. The velocity of the material as determined by job conditions must be maintained to minimize rebound of the mortar.

When using the dry mix method, the Contractor must supply water to the nozzle at a uniform pressure of at least 15 psi greater than the air pressure used to convey the dry mortar mixture.

C. Construction Operations

1. Pre-Placement

Before the Contractor begins to apply mortar, the Inspector should perform the following inspection activities:

a. Ensure that the surface has been properly prepared.

    1. If the Contractor is placing mortar against earth, ensure the area is graded, and compacted with adequate moisture; that joints, side forms, headers, and shooting strips for backing or paneling are provided as required in the Plans, and ground or gauging wires are installed to establish thicknesses, surface planes, and finish lines.

    2. If the Contractor is placing mortar against forms, ensure the forms have been placed in accordance with Section 502 of the Standard Specifications

    3. If the Contractor is placing mortar against concrete or rock, ensure all deteriorated and loose material has been removed; the edges along the perimeter of the repair area are cut square or slightly undercut at least 1 inch deep; the surface has been sandblasted, kept wet for at least 1 hour and allowed to dry just before the mortar is applied.

b. Verify that the Contractor provides proper reinforcing based upon the thickness of the applied mortar.

    1. When the mortar thickness exceeds 1.5 inches, verify that the Contractor uses anchor or driven studs and reinforcing. Ensure that anchor or driven studs are provided in accordance with the Section 521.03.B(1) of this Manual. Ensure that the studs are spaced no more than 12 inches center-to-center on overhead surfaces, 18 inches center-to-center on vertical surfaces, and 36 inches center-to-center on top of horizontal surfaces. At least three anchors must be used in each patch area.

    2. Where the mortar thickness is between 1.5 and 4 inches, the Contractor must reinforce with a single mat of either 2 inch × 2 inch of W1.2 × W1.2, or 3 inch × 3 inch of W1.4 × W1.4 welded wire fabric, unless otherwise required by the Plans.

    3. Where the mortar thickness exceeds 4 inches, the Contractor must reinforce each 4-inch layer of mortar thickness placed with a mat of wire fabric. Each mat of welded wire fabric must be encased in mortar and allowed to set before installing the next layer of mortar. Ensure the welded wire fabric is placed no closer than 0.5 inches to the prepared surface. The welded wire fabric must be placed parallel to and at least 1 inch away from the finished surface. Fabric should be pre-bent to fit around corners and into re-entrant angles.

c. Verify the Contractor has adequate equipment on site to place, finish and cure the mortar.

d. Ensure that the ambient temperature is not anticipated to drop below 35 degrees F within 24 hours after placement.

e. Ensure the nozzleman's experience conforms to the requirements for applying mortar in the intended location.

2. During Placement

During the Contractor's placement operations, the Inspector should perform the following inspection activities:

a. Pneumatically placed mortar may only be applied to surfaces with a surface temperature between 32 and 100 degrees F. Suspend mortar application during high winds or rain.

b. Ensure that the prepared surface is saturated surface dry at the time of mortar placement.

c. Ensure the reinforcement is placed and firmly held in position as specified. Check joints, side forms, shooting strips, and where used, the position of ground or gauging wires.

d. Ensure the Contractor proportions the specified amount of cement and aggregate. Ensure the proper mix is delivered by checking the delivery ticket of the first truck and by also checking the delivery tickets periodically throughout the day.

e. Limit the placing of mortar to lift thicknesses no greater than 4 inches at a time.

f. Periodically check the working pressures of the equipment to ensure they meet specifications.

g. For placing dry or wet mix mortar, ensure the materials are used within 45 minutes of mixing the cement with the aggregate.

h. Through observation, ensure a reasonably smooth and uniform finished surface for the type of work involved. Direct the Contractor to bring low spots or depressions up to proper grade.

i. Watch vertical surfaces to ensure no slough off occurs because of mix that is too wet. Reference any areas that do slough off so they can be carefully sounded later. Any wet mix that does slough off should be removed and then reshot.

j. The nozzleman should make the extra effort to ensure complete encasement of the reinforcement. On double mats of reinforcement, this extra effort will require placing the nozzle through the front mat of the reinforcement and shooting from the sides of large bars to properly place the concrete behind the bars. Verify that mortar fully encases the reinforcing steel. In areas of congested reinforcement, look for voids and rock or sand pockets. If defects are found, ensure that the Contractor removes and replaces the mortar.

k. Ensure that adjacent facilities are protected from damage or discoloration by overspray, dust, or rebound. Immediately clean contacted areas by scraping, brushing, or washing.

3. Finishing

After completing mortar placement, the Contractor must eliminate high spots. If cutting screeds are used, the Contractor should lightly apply the screed without disturbing the mortar, and work the screed in an upward direction on vertical surfaces. Unless otherwise required by the Contract, ensure that the finished mortar surface is given a final flash coat of 0.25 inches of mortar. Verify that a uniform appearance is created on exposed surfaces.

4. Curing and Protecting

Ensure the pneumatically placed mortar is cured in accordance with Section 509.04.F(3) or Section 509.04.F(4) of the Standard Specifications.

The "Water Method" [509.04.F(3)] is the preferred manner of curing and should be strongly recommended. Verify that the mortar is cured for at least 96 hours, and protected from freezing during the curing period in accordance with Section 509.04.B of the Standard Specifications.

The "Liquid Membrane Curing Compound Method" [509.04.F(4)] should only be used when the Water Method is not practical. Membrane curing should only be allowed when drying conditions are not severe; and where no additional mortar, stain or paint is to be applied. Coverage rates for rough finished surfaces should be performed at twice the normal application rate.

D. Safety and Environmental Considerations

Ensure the Contractor does not dispose of excess mortar in waterways, as discussed in the following video.

Ensure that the Contractor complies with its plan to protect workers and traffic during construction. This includes:

- Providing fall protection for workers,
- Preventing tools, material etc. from falling on traffic beneath,
- Providing traffic control during construction,
- Protecting the public and adjacent structures from rebound and overspray, and
- Ensuring Contractor personnel use personal protection equipment while applying the mortar.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- When surface preparation begins and the method used
- When forms, welded wire, reinforcing steel or studs are placed, if required
- When the pre-mortar inspection occurred and who was in attendance, note any deficiencies observed and list any corrective actions identified.

- When the mortar is placed
- Whether or not proper curing method is being performed and note any deficiencies observed and corrective actions taken
- When the texturing is performed
- Any conditions requiring corrective actions, and individual contacted and their recommendations
- Document who performs the corrective actions

2. Measurement and Payment

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

Documentation of this Square Yard item will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template.

- Select the appropriate pay item from the list of contract pay items.
- Open the 'DWR Templates' icon in the toolbar.
- Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to be used as the method of documentation for the work performed.
- Select the appropriate method of measurement from the Type radio button options. Depending on the option selected, enter the following information:

(a) Two Dimensional Measured Quantity Option.

This option can be used to allow the template to calculate areas for progressive payments or for documenting the final quantity. Typically this option will be used for areas involving simple calculations which will only require length and width.

1. In the appropriate fields, enter both a descriptive location and the station to station extents.
2. Input the measured length and width to calculate an area.
3. For additional areas or additional locations, with different dimensions, select the 'New Row' button.

(b) Calculated Quantity Option.

This option will allow the input of quantities calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), and can be used for progressive payments or for documenting the final quantity of areas. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

1. In the appropriate fields, enter both a descriptive location and the station to station extents.

2. In the Placed Quantity field, enter the calculated quantity (SY) of the item completed.

3. In the Book/Folder/Envelope # field provide the location of the documentation for the calculations.

For additional areas or additional locations, with different dimensions, select the 'New Row' button.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

521.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

None required.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

Verify that the repaired areas are cleaned up daily. This includes picking up trash and debris from the project site.

The Contractor must protect the finished surface from damage by other operations or equipment until mortar has attained sufficient strength.

Prior to the progression of construction, visually inspect the placed mortar for variations in appearance including the color, texture, consolidation, etc. Changes in the appearance could indicate inconsistencies in the materials incorporated in the mortar or with its handling and placement. If changes in appearance are observed, bring them to the Resident Engineer's attention as additional sampling, testing and evaluation may be warranted.

Ensure that the curing requirements are complied with for the specified length of time.

Monitor thermometers on the mortar elements. If the temperature drops below 32 degrees F, ensure the Contractor takes corrective actions to prevent freezing of the mortar.

CHECKLIST – PNEUMATICALLY APPLIED MORTAR

Part 1: Preconstruction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Contractor's proposed sources of materials are acceptable.					
Contractor's mix design is acceptable.					
The Contractor has adequate equipment on site to place, finish and cure the mortar.					
The ambient temperature is not anticipated to drop below 35 degrees F within 24 hours after placement					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Proper Surface Preparation – Earth:					
Area is graded in accordance with the Plans.					
Area is compacted with adequate moisture.					
Area is free of standing water prior to placement.					
The required joints, side forms, headers, and shooting strips for backing or paneling are provided.					
Ground or gauging wires are installed to establish thicknesses, surface planes, and finish lines.					
Proper Preparation – Concrete or Rock:					
Deteriorated and loose material is removed with pneumatic or hand tools.					
The edges along the perimeter of the repair area are cut square or slightly undercut at least 1 inch deep.					
The surface is sandblasted to clean rust from exposed steel and to produce a clean, rough surface.					

Part 2: During Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
The surface is kept wet for at least 1 hour and allowed to dry just before mortar is applied.					
Proper Preparation – Forms:					
Contractor provides forms in accordance with Section 502 of the Standard Specifications.					
Mortar Placement, Finishing, & Curing:					
Surface temperature is between 32 and 100 degrees F.					
The prepared surface is saturated surface dry at the time of mortar placement.					
Contractor is using the specified materials and mix proportions.					
Contractor places mortar in lifts of no thicker than 4 inches at a time.					
Materials are used within 45 minutes of mixing the cement with the aggregate.					
Contractor achieves a reasonably smooth and uniform finished surface.					
Low spots or depressions are brought up to proper grade.					
Adjacent facilities are protected from damage or discoloration by overspray, dust, or rebound.					
After completing mortar placement, Contractor eliminates all high spots.					
The finished mortar surface is given a final flash coat of 0.25 inches of mortar.					
Pneumatically placed mortar is cured in accordance with Section 509.04.F(3) or Section 509.04.F(4).					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Contractor properly disposes of excess mortar.					
Contractor protects the finished surface from damage by other operations or equipment until mortar has attained sufficient strength.					
Contractor protects the mortar from freezing.					
A uniform appearance is created on exposed surfaces.					

SECTION 523 – CONCRETE SURFACE REPAIR BY SEALING

523.01 GENERAL

This work consists of sealing bridge decks and approach slabs and filling and rebonding cracks.

523.02 PRECONSTRUCTION CONSIDERATIONS

A. Preconstruction Meeting

Discuss the following at the Preconstruction Meeting:

- Contractor's work plan including surface preparation techniques, materials, and the installation procedures (floodcoating or individual crack sealing).
- Contractor's proposed methods of traffic control.
- Contractor's source of materials, material safety data sheets (MSDS) and product data sheets (PDS).
- Equipment requirements.
- Manufacturer's representative must be on-site to approve the concrete surface preparation and application of the sealant.
- Contractor's proposed schedule for work and any restrictions detailed in the Plans and Contract.
- Resident Engineer must verify the surface preparation before the application of sealant.
- Method to be used to broadcast sand over the sealant surface for floodcoats.

B. Acceptance of Materials

Verify that the High Molecular Weight Methacrylate (HMWM) or the epoxy resin penetrant proposed by the Contractor is an approved product shown on the Approved Products List (APL) [add link]. If the proposed material is not on the APL, contact Materials Division.

Ensure the Contractor provides its proposed source of material for the sand. As soon as practical, the Inspector should obtain a sample of the sand for conformance with the gradation requirements of Table 523:1 of the Standard Specifications.

C. Preparatory Work and Contractor Work Plans

If water repellant is required by the Plans, the water repellant must be applied prior to crack sealing.

The concrete surfaces must be allowed to dry for at least 48 hours after rain, before application of the sealant. If sealing cracks in new concrete surfaces, ensure the concrete has been allowed to cure for at least 28 days before applying the sealant.

Ensure all foreign materials are removed from the concrete surfaces. The Contractor may need to employ alternate methods to remove any materials that will not be removed by their proposed method of surface preparation.

For full depth cracks, the Contractor must be prepared to close up the bottom of the crack to prevent loss of sealant material. Duct tape, caulking, wooden forms, etc. may be used to prevent sealant loss.

The Contractor may fill cracks wider than 1/8 inch with sand (in accordance with Table 523:1 of the Standard Specifications) before application of sealant.

D. Safety and Environmental Issues

The mixing of some brands of High Molecular Weight Methacrylate (HMWM) creates a highly explosive material, and extreme care must be taken when mixing these products. Three component HMWM products are more dangerous than two component systems. Refer to the MSDS for product details.

Discuss with the Contractor its plan to protect workers and traffic during construction. This plan should address the following:

- Proper storage of HMWM sealants to prevent a violent reaction or explosion,
- Shielding traffic from surface preparation debris,
- Preventing traffic from driving on unsanded sealant (like driving on ice),
- Traffic control during construction,
- Fall protection for workers,
- Preventing tools, material etc. from falling on traffic beneath, and
- Collection, storage, and disposal of concrete slurry, if any, produced by the surface preparation techniques.

523.03 INSPECTION GUIDELINES DURING CONSTRUCTION

A. Acceptance of Materials

Ensure the High Molecular Weight Methacrylate (HMWM) or the epoxy resin penetrant provided by the Contractor is an approved product shown on the Approved Products List (APL) [add link] [Document in Template AM5001]. If the provided material is not on the APL, contact Materials Division.

Ensure the Contractor provides sand with a maximum moisture content of one-half of the percent absorption of the aggregate (i.e. dry sand). Verify the sand is free of dirt and other organic materials, and in accordance with the gradations in Table 523:1 of the Standard Specifications.

B. Equipment and Methods

Ensure the Contractor employs at least one of the following types of equipment for surface preparation:

- Sand-Blasting - a water and oil-free compressed air pressure sand-blaster with an air pressure of at least 90 psi

- Shot-Blasting - a portable machine that uses a recyclable steel shot blast technique

After surface preparation, verify that surfaces and cracks are cleaned using compressed, dry, and oil-free air with an air pressure of at least 90 psi.

C. Construction Operations

1. General Sealing Requirements

Verify the concrete surfaces have been allowed to dry for at least 48 hours after rain. If sealing cracks in new concrete surfaces, verify the concrete has been allowed to cure for at least 28 days before applying the sealant.

Ensure all foreign materials have been removed from the concrete surfaces. The Contractor must abrasively blast and remove traces of asphalt or petroleum, excess grout, and concrete curing agents. Verify that all surfaces and cracks are cleaned using compressed, dry, and oil-free air with an air pressure of at least 90 psi. The Contractor may need to employ alternative methods (hand scraping or brushing, etc.) to remove any materials that were not removed by their proposed method of surface preparation.

For full depth cracks, verify the Contractor has closed up the bottom of the crack to prevent loss of sealant material.

Contractor may fill cracks wider than 1/8 inches with sand (in accordance with Table 523:1 of the Standard Specifications) before application of sealant.

Ensure sealant application is performed when the surface temperature is between 45 and 90 degrees F.

Verify sealant is mixed and placed in accordance with the manufacturer's recommendations.

2. Sealing Individual Cracks

The Contractor must verify the size of the cracks using a crack comparator. Any cracks wider than 1/8 inches may be filled with sand.

Ensure that the individual cracks are masked off using tape approximately 1 inch on each side of the crack.

Ensure the Contractor seals cracks by placing sealer in the surface cracks and not on the entire deck.

Verify sealant is mixed and placed in accordance with the manufacturer's recommendations, and the Contractor continues to fill each crack until the sealant will no longer penetrate.

The Contractor must immediately cover the filled crack with sand before the sealer hardens. If the sand is applied after the sealant begins to harden it will not become embedded and will merely brush off with the first wave of traffic leaving a potentially slick surface.

3. Sealing Entire Deck by Floodcoat

For flood coats, ensure a technical representative from the manufacturer is on the site during the sealant application. Make sure the requirement for the presence of the manufacturer's representative is enforced even if the Contractor has vast experience with this feature of work

Verify sealant is mixed and placed in accordance with the manufacturer's recommendations.

The Contractor must sweep, squeegee, pour, or spray the area so the sealant can flow into all of the cracks. Monitor the penetration rate of the sealant, as larger cracks will require a greater amount of sealant than smaller ones will. Do not allow large cracks to "starve" for sealant.

After the sealant fills the cracks, ensure the Contractor sweeps excess sealant, especially from the tine marks, before the material begins to gel. Ensure that the sealant does not plug the tined surface of the bridge deck.

To improve skid resistance, ensure the Contractor broadcasts sand onto the sealant by hand, or with a machine, before the sealant hardens on the treated area. The sand must be applied at a uniform coverage rate from 0.55 lb/yd^2 to 0.65 lb/yd^2. The application of sand is required to give the sealed surface a rough texture to assist with traction. If the sand is applied after the resin begins to harden it will not become embedded and will merely brush off with the first wave of traffic leaving a very slick and hazardous surface.

D. Safety and Environmental Considerations

The mixing of some brands of High Molecular Weight Methacrylate (HMWM) creates a highly explosive material, and extreme care must be taken when mixing these products. Three component HMWM products are more dangerous than two component systems. Refer to the MSDS for product details.

Ensure that the Contractor complies with its plan to protect workers and traffic during construction. This includes:

- Properly storing HMWM sealants to prevent a violent reaction or explosion,

- Shielding traffic from surface preparation debris,
- Preventing traffic from driving on unsanded sealant (like driving on ice),
- Providing traffic control during construction
- Providing fall protection for workers,
- Preventing tools, material etc. from falling on traffic beneath, and
- Properly collecting, storing and disposing of concrete slurry, if any, produced by the surface preparation techniques.

E. Documentation

1. Daily Work Report

Record the following information, as appropriate:

- Location and description of work being performed (i.e. Bridge ‘A’, Span #1, Cleaning and Sealing Cracks)
- Conditions affecting the progress of or delaying prosecution of the work, equipment break downs, etc.
- Discussion of project prosecution with the Contractor that are of an unusual nature and any specific recommendations or instructions to the Contractor
- Weather Conditions during application and curing
- **Any conditions requiring corrective actions, and individual contacted and their recommendations**
- Document who performs the corrective actions

-

2. Measurement and Payment

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the change order (i.e. description, explanation, attachment, etc.).

(a) Linear Foot Unit of Measure Pay Item

Measure and calculate the quantity of Sealer Crack Preparation complete in place utilizing drawings, spreadsheets, hand calculations, etc.

Documentation of this item will be performed within the SiteManager / Daily Work Reports / Work Items tab.

1. Select the appropriate pay item from the list of contract pay items.

2. In the appropriate field, enter the descriptive location (i.e. Bridge ‘A’ – Span #1) or the station and location.

3. In the Placed Quantity field enter the linear foot of crack prepared for sealer resin complete in place.

(b) Gallon Unit of Measure Pay Item

Determine the quantity of Sealer Resin placed utilizing the supplier’s invoice and paying to the nearest whole container (i.e. five gallon bucket) of resin placed.

Documentation of this item will be performed within the SiteManager / Daily Work Reports / Work Items tab.

1. Select the appropriate pay item from the list of contract pay items.

2. In the appropriate field, enter either a descriptive location (i.e. Bridge ‘A’ – Span #1) or the station and location.

3. In the Placed Quantity field, enter the quantity of resin placed complete in place.

(c) Square Yard Unit of Measure Pay Item

Documentation of this Square Yard item will be performed within the SiteManager / Daily Work Reports / Work Items tab / DWR Template.

1. Select the appropriate pay item from the list of contract pay items.

2. Open the ‘DWR Templates’ icon in the toolbar.

3. Select the payment option from the drop down list (Progressive Estimate or Audit Adjustment) that is going to be used as the method of documentation for the work performed.

4. Select the appropriate method of measurement from the Type radio button options. Depending on the option selected, enter the following information:

   a. Two Dimensional Measured Quantity Option.

   This option can be used to allow the template to calculate areas for progressive payments or for documenting the final quantity. Typically this option will be used for areas involving simple calculations which will only require length and width.

   (1) In the appropriate fields, enter both a descriptive location and the station to station extents.
   (2) Input the measured length and width to calculate an area.
   (3) For additional areas or additional locations, with different dimensions, select the 'New Row' button.

   b. Calculated Quantity Option.

   This option will allow the input of quantities calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), and can be used for progressive payments or for documenting the final quantity of areas. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

   (1) In the appropriate fields, enter both a descriptive location and the station to station extents.
   (2) In the Placed Quantity field, enter the calculated quantity (SY) of the item completed.
   (3) In the Book/Folder/Envelope # field provide the location of the documentation for the calculations.
   (4) For additional areas or additional locations, with different dimensions, select the 'New Row' button.

(d) Documentation Procedures for the Concrete Surface Repair by Sealing Pay Items

1. Sealer Crack Preparation (LF) - This pay item will be documented utilizing the DWR Work Items tab.

2. Sealer Resin (GAL) - This pay item will be documented utilizing the DWR Work Items tab.

3. Deck Area Sealed (Flood Coats) (SY) - This pay item will be documented utilizing the DWR template for Square Yard (SqYd) or the DWR Work Items tab.

In the Book/Folder/Envelope # field of the final DWR Template (Audit Adjustment), provide the physical location (Folder #, Envelope #, File, etc.) of the supporting documentation for the quantities shown. Add link for screen shot of the Template.

523.04 POST-CONSTRUCTION CONSIDERATIONS

A. Acceptance of Materials

None required.

B. Audit Requirements

When pay items are Pay Plan Quantity, no calculations will be required. Documentation of a Pay Plan Quantity item may be performed within the SiteManager / Daily Work Reports / Work Items tab. Authorized deviations from plan quantity must be documented by a change order. The authorized quantity deviation must be documented in the appropriate DWR Template or in the change order (i.e. description, explanation, attachment, etc.).

When quantities are calculated outside of the template (i.e. spreadsheet, hand calculations, etc.), calculations must be placed in a Book, Folder or Envelope for comparison with the quantities on the Contract Item Work Report. Typically this option will be used for areas involving multiple dimensions, irregular shapes, etc.

Utilize the Contract Item Work Report within SiteManager to verify that correct quantities have been placed and paid. Add link for screen shot of the Report, SSS Database, etc. Compare the Contract Item Work Report with the documentation provided for each pay item to verify the accuracy of the quantities submitted and to ensure that no features or gaps in the extents of the work were omitted or duplicated. If the basis of payment is Plan Quantity, ensure that the total quantity paid equals the plan quantity.

C. Protection of the Work

The Contractor may resume traffic when the Inspector determines the surface is tack-free and the sand resists brushing by foot.

CHECKLIST – CONCRETE SURFACE REPAIR BY SEALING

Part 1: Preconstruction

Issue	Yes	No	N/A	Comments	Initials
All foreign materials are removed from the concrete surfaces.					
Surfaces and cracks are cleaned using compressed, dry, and oil-free air with an air pressure of at least 90 psi.					
Contractor properly stores and handles HMWM.					

Part 2: During Construction

Issue	Yes	No	N/A	Comments	Initials
Water repellant is applied prior to crack sealing, if required by Contract.					
Surface is allowed to dry for 48 hours after rain before application of sealant.					
For new concrete surfaces, the concrete has been allowed to cure for at least 28 days.					
For full depth cracks, the Contractor has closed up the bottom of the crack to prevent loss of sealant material.					
Sealant is applied when the surface temperature is between 45 and 90 degrees F.					
Sealant is mixed and placed in accordance with the manufacturer’s recommendations.					
Sealant fully penetrates the cracks.					
For flood coats, a technical representative from the manufacturer is on the site during the sealant application.					
Sand is applied onto the sealant before it begins to harden.					

Part 3: Post-Construction					
Issue	**Yes**	**No**	**N/A**	**Comments**	**Initials**
Sand applied to sealed cracks resists brushing off.					