Section 712. BRIDGE REHABILITATION — CONCRETE

712.01. Description. This work consists of removing concrete and patching or resurfacing with concrete patching, or overlay mixtures and removing, replacing, and retrofitting expansion joints and structural concrete portions of existing bridges.

712.02. Materials. Provide materials in accordance with the following:

Concrete, Grade S2 and D ............................................................. 701
Mortar and Grout ............................................................................ 702
Structures Patching Mixtures ......................................................... 703
SFMC Overlay Mixtures ................................................................. 703
LMC Overlay Mixtures .................................................................... 703
Granular Material, Class II .......................................................... 902
Fine Aggregate 2MS ....................................................................... 902
Polypropylene Fibers ...................................................................... 903
Insulating Blankets ......................................................................... 903
Latex Admixtures ........................................................................... 903
Steel Reinforcement ................................................................. 905
Bar Reinforcement ........................................................................... 905
Anchor Bolts .................................................................................. 908
Geotextiles ...................................................................................... 910
Water .............................................................................................. 911
Epoxy Resin Adhesive .................................................................... 914
Epoxy Mortar .................................................................................. 914
Mechanical Expansion Anchors ..................................................... 914

Do not use chloride admixtures. Provide Grade S2 concrete for filler walls.

Provide adhesive anchors, mechanical expansion anchors, and mechanical reinforcement splices selected from the Qualified Products List.

Provide embedded galvanic anodes selected from the Qualified Products List.

Provide Type H-1 grout for use under masonry plates, selected from the Qualified Products List.

Provide threaded reinforcing bars with threaded couplers, approved by the manufacturer for use with the product.

Provide anchor bolts and washers hot-dip galvanized in accordance with AASHTO M 232.
Provide Silica Fume Modified Concrete (SFMC) or Latex Modified Concrete (LMC) for concrete bridge deck overlay.

712.03. Construction.

A. Equipment.

1. Equipment for Preparation of Existing Concrete.

   a. Sawing Equipment. Provide sawing equipment capable of sawing concrete to the depth required by the contract.

   b. Scarifying Equipment. Provide a power operated, mechanical scarifier capable of removing the concrete surface to at least \( \frac{1}{4} \) inch deep, with each pass. Attach a short ski, shoe, or other device, to the cutter head to limit the cut depth.

   c. Blast Cleaning Equipment. Provide blast cleaning equipment that uses abrasive or high-pressure water to remove rust scale from reinforcing bars and small chips of loosened concrete. Select dry abrasive from the Qualified Products List.

   d. Superstructure Concrete Removal Equipment. Obtain the Engineer's written approval for the proposed sequence and method of removal, before removing portions of the bridge superstructure. Provide equipment for removing superstructure concrete in accordance with the following:

      i. Removing Superstructure Concrete on Steel Beams. For removing superstructure concrete on steel beams, the Contractor may use machine-mounted hydraulic or pneumatic equipment for full or partial deck removals, sidewalks, curbs, barriers, and railings.

      ii. Removing Superstructure Concrete on Prestressed Concrete I-Beams. For removing superstructure concrete on prestressed concrete I-beams, the Contractor may use machine-mounted hydraulic or pneumatic equipment in areas on the bridge decks between prestressed concrete beams. Use manual pneumatic hammers to remove the bridge deck over prestressed concrete beams. Use manual pneumatic hammers to remove diaphragms. Limit manual pneumatic hammers to 60 pound maximum.

      iii. Removing Superstructure Concrete on Prestressed Concrete Spread Box Beams or 1800 Beams. For removing superstructure concrete on prestressed concrete

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spread box beams or 1800 beams, do not use machine-mounted hydraulic or pneumatic equipment on full or partial deck removals. The Contractor may use this equipment to remove sidewalks, curbs, barriers, and railings. Use manual pneumatic hammers to remove bridge deck over the prestressed concrete beams. Use manual pneumatic hammers to remove diaphragms. Limit manual pneumatic hammers to 60 pound maximum.

iv. Removing Superstructure Concrete on Prestressed Concrete Side-By-Side Box Beams. For removing superstructure concrete on prestressed concrete side-by-side box beams, do not use machine-mounted hydraulic or pneumatic equipment on full or partial deck removals, or to remove sidewalks, curbs, barriers, and railings that rest directly on the prestressed concrete beams. The Contractor may use this equipment to remove sidewalks, curbs, barriers, and railings that do not rest directly on prestressed concrete beams. Use hydrodemolition or manual pneumatic hammers to remove concrete decks, sidewalks, curbs, barriers, and railings that rest directly on prestressed concrete beams. Limit manual pneumatic hammers to 60 pound maximum.

v. Removing Superstructure Concrete at Expansion and Construction Joints on Concrete Beam Bridges. For removing superstructure concrete at expansion and construction joints, do not use machine-mounted hydraulic or pneumatic equipment for removing superstructure concrete around expansion or construction joints on concrete beam bridges. The Contractor may use manual pneumatic hammers, limited to 60 pound maximum.

vi. Removing Superstructure Concrete at Expansion and Construction Joints on Steel Beam Bridges. For removing superstructure concrete at expansion and construction joints the Contractor may use machine-mounted hydraulic or pneumatic equipment on steel beam bridges. Limit the impact energy of machine mounted hydraulic or pneumatic hammers to a maximum rating of 300 foot-pounds, or an AEM/CIMA Tool Energy Rating of 130 foot-pounds. Use a conical or a moil point. The Engineer will not allow machine-mounted hydraulic or pneumatic hammers for removing joints within 12 inches of beam edges or within 6 inches of transverse sawcut lines.
Use machine-mounted hydraulic or pneumatic hammers before constructing bridge deck overlays. The Contractor may use manual pneumatic hammers, limited to 60 pound maximum.

2. **Hydrodemolition Equipment.**
   a. **Equipment Description.** Use equipment that operates at a noise level less than 90 dbA, as measured from a distance of 50 feet. Use potable water in hydro-demolition operations. Provide equipment shielding to prevent injury or damage from flying debris, in accordance with subsection 104.07.B.
   b. **Equipment Demonstration.** The Engineer will designate two trial areas on the bridge deck for the Contractor to demonstrate that equipment, personnel, and methods of operation produce results satisfactory to the Engineer.

   Complete required scarification before the demonstration.

   The first trial area consists of 30 square feet of sound concrete, as determined by the Engineer. Calibrate equipment to remove the sound concrete to the depth shown on the plans. Move the equipment to a second trial area that consists of deteriorated or defective concrete, and determine if the calibration for sound concrete will completely remove the unsound concrete.

   If the equipment does not completely remove the unsound concrete, obtain another piece of equipment and perform another demonstration. The Engineer will not adjust the project completion date due to delays in obtaining equipment.

   Begin production removal only if the Engineer determines results are satisfactory. If the Engineer determines equipment does not adequately remove concrete, the Engineer may require equipment recalibration during production work.

3. **Concrete Overlay Surface Construction Equipment.** Provide hand tools for placing freshly mixed concrete. Use a finishing machine with a self-propelled screed, at least one powered roller, augers, and vibratory pan set at a vibration rate recommended by the manufacturer. Provide a finishing machine capable of moving forward and backward under positive control.

   Raise screeds to clear the screeded surface if traveling in reverse. Obtain the Engineer’s approval for modifications to the finishing equipment.
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Operate the screed on longitudinal screed rails, capable of carrying imposed loads between supports with a deflection no greater than \( \frac{1}{16} \) inch. Use rail sections, straight within \( \frac{3}{4} \) inch over 10 feet. Place the rail sections within \( \frac{1}{16} \) inch of the required screed grade. Attach rails to the surface to allow vertical adjustments and removal without damage to the new surface.

Use vibratory equipment to consolidate hand-finished areas and along construction joints and bulkheads. For areas with epoxy coated, or other coated reinforcement, use a vibrator with a rubber coated head.

The Contractor may use truss type vibrating screeds when conditions warrant if approved by the Engineer.

4. Joint Cleaning Equipment.
   a. Air Compressors. Use compressors with oil-free and moisture-free air, and a nozzle pressure of at least 90 psi.
   b. Abrasive Blasting Equipment. Use abrasive blasting equipment capable of cleaning as required, with a nozzle pressure of at least 90 psi. Use nozzles sized for the width of joint and replace them if enlarged by wear.

5. Adhesive Injection Equipment. Inject adhesive with positive displacement equipment, with fixed ratio and automatic mixing of two components at the nozzle. Provide equipment with drain-back plugs and a nozzle arrangement capable of adhesive injection, at a pressure no greater than 120 psi, without defacing concrete.

6. Blast Cleaning Equipment. Provide blast cleaning equipment with dry abrasive or high-pressure water to remove laitance, deleterious material, including old curing material and pavement marking paint. Select the abrasive from the Qualified Products List.

B. False Decking. Construct false decking in accordance with subsection 706.03.B.

C. Superstructure Concrete Removal. Mark out beam and diaphragm locations before beginning removal operations. If removing decks, sidewalks, curbs, barriers, and railings, do not damage the concrete and retained steel portions of the superstructure. Repair damage to retained portions to the Engineer’s satisfaction at no additional cost to the Department.
If incorporating part of the deck into new construction, make a 1 inch deep saw cut on the top and bottom of the deck at the limits of removal shown on the plans.

If sawing to section the deck for removal, cut no greater than 90 percent of the full depth of the deck over the steel or prestressed concrete beams to avoid cutting the top flange.

Saw cut the front and back vertical steel reinforcement in sidewalks, curbs, barriers, and railings before removal.

On prestressed concrete spread box beams and 1800 beams, saw cut the deck between the beams full depth, parallel to the beams, and remove in sections. Remove the deck over the beams using manual pneumatic hammers.

D. **Removal or Revisions to Bridge Deck Joints.** Remove or extend and modify existing bridge deck joints. Clean structural steel exposed during concrete removal in accordance with SSPC-SP3, Power Tool Cleaning. Using a brush, coat exposed structural steel with 5 mils to 10 mils of aluminum-filled epoxy mastic. Protect the work and environment in accordance with section 715. Remove and reinstall portions of existing thrie beam guardrail to access joints for removal.

E. **Scarifying Bridge Decks.**

1. **Scarifying.** Close the structure to traffic. Scarify the concrete surface requiring overlay to at least ¼ inch deep. If the use of a scarifier is not practical, remove concrete using hand methods. Avoid damaging steel reinforcement.

   Do not scarify within 6 feet of new deck overlay until the overlay cures at least 48 hours.

   Only allow construction vehicles required to conduct the work onto scarified surfaces.

2. **Determination of Unsound Concrete.** After structure scarifying and cleaning, the Engineer will mark areas of unsound concrete.

F. **Hand Chipping.** Use hand methods to remove concrete next to exposed reinforcing steel, concrete from spalled areas, unsound concrete from Engineer-marked areas, epoxy patches, hot mix asphalt (HMA) patches, and other unsound material, as determined by the Engineer.

   Do not hand chip within 6 feet of new overlay until it cures at least 48 hours.
Blast clean to remove scale or accumulated rust from reinforcing steel.

1. **Hand Chipping Bridge Deck Concrete.** For areas requiring patching or leveling, remove unsound concrete and other detrimental material, as determined by the Engineer, using air chisels, scarifying machines, or milling. Blast clean the area. If directed by the Engineer, saw cut the area requiring patching or filling on decks not requiring overlay, to the required line and depth. If deep hand chipping is required, remove concrete to at least ¾ inch below exposed steel.

   Install edge forms to the grade shown on the plans, if areas requiring patching lie next to a joint. If full depth removal of deck portions is required, install false decking in accordance with subsection 706.03.B.

   Remove loose material from area requiring patching and clean with oil-free compressed air. Flush the area with clean water under pressure and remove excess water by air blasting immediately before applying patching mixture.

   Clean structural steel exposed during concrete removal in accordance with SSPC-SP3, Power Tool Cleaning. Coat exposed structural steel with 5 mils to 10 mils of brushed-on aluminum-filled epoxy mastic before recasting concrete. Protect the work and environment in accordance with section 715.

2. **Hand Chipping Concrete Other Than Deck Concrete.** Remove unsound or loose concrete with air hammers, or other Department-approved methods. Saw-cut areas requiring patching or filling to an edge depth of at least ½ inch, along a line determined by the Engineer. Remove concrete to at least 3 inches, as measured from the concrete surface. Remove concrete from exposed reinforcing steel to provide clearance of at least ¾ inch around the steel.

   Remove loose material. Blast clean, and blow out the area with oil-free compressed air.

   If areas requiring patching lie next to joints, install edge forms to the line shown on the plans. Remove loose material from areas requiring patching and cleaning with oil-free compressed air. Flush the area with clean water under pressure and remove excess water by air blasting immediately before applying patching mixture. Place patches in accordance with subsection 712.03.O.
G. Hydrodemolition. Remove deck concrete and concrete patches with high-pressure water jets. If hydrodemolition is not practical, use hand methods to remove areas.

Remove HMA patches in accordance with subsection 501.03. Remove patches by hydrodemolition, 60-pound pneumatic hammers, or other equipment approved by the Engineer. Clean debris from the deck, before beginning the first pass of concrete hydrodemolition. If using hydrodemolition equipment to remove HMA patches, complete work before the first pass for concrete removal.

Use hydrodemolition to the limits shown on the plans or as determined by the Engineer.

If the plans show limits of hydrodemolition, make one pass of the hydrodemolisher to remove sound concrete to the depth and limits required. Avoid removing sound concrete beyond the required depth. Remove deteriorated or defective concrete within the limits required.

If the plans limit hydrodemolition to deck portions the Engineer determines contain unsound concrete, scarify the entire deck first. The Engineer will mark and measure areas determined as unsound. Make one pass of the hydrodemolisher over these areas with equipment calibrated in accordance with subsection 712.03.A.2.b.

The Engineer will determine and mark areas of unsound concrete remaining after the first pass, as specified in subsection 712.03.E.2. Remove unsound areas with a second pass of the hydrodemolisher, 60-pound pneumatic hammers, or other equipment approved by the Engineer. Make the second pass with the hydrodemolition equipment calibrated the same as for the first pass.

Remove concrete debris by hand or mechanical methods immediately after hydrodemolition. Remove debris that settles on, or adheres to, the surface of sound concrete, at no additional cost to the Department.

Avoid damage to remaining sound concrete or exposed reinforcement. If more than 3 inches of deteriorated concrete is removed, the Engineer will not allow heavy equipment, including vacuum trucks for removing concrete debris and concrete trucks, on the deck. Following debris removal, and before placing overlay, blast clean the surface with abrasive or water to remove bond-breaking residue or loose material from concrete surfaces, and rust from steel reinforcement.

Clean structural steel exposed during concrete removal in accordance with SSPC-SP3 Power Tool Cleaning, and brush on a 5-mil to 10-mil
coat of aluminum-filled epoxy mastic. Protect the work and environment in accordance with section 715.

Sample, test, monitor, manage, neutralize, and discharge hydrodemolition runoff water from bridge decks. Collect, filter, and dispose of runoff water generated by hydrodemolition. Obtain required permits and comply with regulations concerning runoff water disposal. Do not allow runoff water to create a hazard to the adjacent, or underlying traveled roadway surfaces. Protect existing berm slopes from scouring by water jet or runoff water. Do not allow runoff water, filtered or unfiltered, to enter storm sewers, bridge drain downspouts, or bridge approach downspouts. Do not discharge runoff water, filtered or unfiltered, into surface water, floodplains, or wetlands.

In areas with enclosed drainage systems or areas where the contract does not allow runoff discharge, collect, haul, and dispose of runoff water as a liquid industrial waste in accordance with section 107.

H. End Header Replacement. Remove the end header of bridge decks and rebuild decks and adjacent approaches in the removal area, as shown in the contract.

I. Exposed Steel Reinforcement. Blast clean to remove scale or accumulated rust from reinforcing steel. Supplement broken or missing reinforcement and bars that have lost ¼ or more of the original bar diameter by splicing in new bars with a lap length of 35 bar diameters, or as directed by the Engineer. If the bond between existing concrete and reinforcing steel is destroyed, remove concrete next to the bar to at least ¾ inch deep, except on bridge decks with lower bar mat clearances that make this impractical. Do not displace or damage exposed reinforcing steel. Remove exposed waterstops. Adjust reinforcing steel to provide cover as shown on the plans.

Wire tie exposed, untied reinforcing bar laps and intersections as follows.

1. **Bar Laps.** Tie bar laps in at least two locations. If sound concrete bonded to reinforcing bars prohibits tying bar laps, remove concrete to tie the bars as required.

2. **Bar Intersections.** Tie bar intersections at every third intersection. If sound concrete bonded to reinforcing bars prohibits tying a bar intersection, or tying the third intersection, tie the next nearest intersection. Do not remove sound concrete bonded to reinforcing bars to tie the required bar intersections.

J. Anchoring Reinforcing Bars or Bolts with Adhesive. Place adhesive when the concrete and steel temperature is at least 50 °F and
rising. The Contractor may use artificial heat to warm concrete and bars or bolts. Do not heat above 180 °F.

Drill holes, remove unsound concrete and dust, fill drilled holes with adhesive, and install reinforcing bars or bolts.

Maintain concrete and steel surfaces, that the adhesive will contact, free of contamination.

1. **Anchoring Bars or Bolts.** Propose complete details of drilling, cleaning, and bonding systems for anchoring reinforcement and submit for the Engineer's approval before use. Propose a drilling method that does not cut or damage existing reinforcing steel. Prepare at least three proof test anchors in the required position, on a separate concrete block, in the presence of the Engineer. The Engineer will proof test the proposed systems. The Engineer will base approval of the anchoring system on the following criteria:
   a. Pull-out tests show that 125 percent of the bar yield strength can be developed;
   b. Bars bond to the concrete at least 90 percent of the embedded bar length and circumferential area; and
   c. Average bar slippage at yield strength does not exceed \( \frac{1}{16} \) inch.

Locate the steel reinforcement with a pachometer, or other Department-approved method, before drilling holes. Remove loose concrete, dust, dirt, and oil from holes by flushing with water under pressure and mechanical agitation. Blow out the holes with oil-free compressed air and dry before applying adhesive.

Clean reinforcing steel of loose scale, rust, oil, and dirt and dry before installation. Prepare adhesive for installation in the hole in accordance with the manufacturer's directions. Place adhesive in the hole to completely fill the space between bar and hole surface for the entire hole depth.

2. **Field Testing.** Conduct field testing, during the first production day, at three locations selected by the Engineer. Provide adequate notice to allow the Engineer to witness this field testing. Use a tension testing device in accordance with ASTM E 488. Provide a copy of a certified calibration for the tension testing device. Update the calibration annually. The Engineer may conduct random pull-out tests for acceptance. In order to be considered passing tests, field tests performed by the Contractor and random tests performed by the Engineer must show that 90 percent of the bar yield strength develops with less than \( \frac{1}{16} \) inch slip.
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Repair damage to epoxy coating.

K. **Mechanical Expansion Anchored Bolts.** Propose a drilling method to ensure no damage or cuts to existing reinforcing steel. Locate steel reinforcement by a pachometer or other Department-approved method before drilling the holes. Drill holes of the required size and depth. Remove unsound concrete. Clean the hole with oil-free compressed air, brush, and clean out with air again. Do not elongate holes. The Engineer will proof test proposed anchors before use.

1. **Anchoring Bolts.** Provide a copy of the manufacturer’s product data sheet and installation procedure for the anchors, showing the ultimate load of the anchor at the required embedment depth. Prepare the proof test on a separate concrete block, or on the structure, in a location approved by the Engineer. Ensure anchors develop the proof tensile, or pull-out, loads specified in Table 712-1.

<table>
<thead>
<tr>
<th>Table 712-1</th>
<th>Anchor Bolt Specifications</th>
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</thead>
<tbody>
<tr>
<td>Diameter (in)</td>
<td>Load (lb)</td>
</tr>
<tr>
<td>%</td>
<td>3,500</td>
</tr>
<tr>
<td>%</td>
<td>6,400</td>
</tr>
<tr>
<td>%</td>
<td>10,200</td>
</tr>
<tr>
<td>%</td>
<td>15,000</td>
</tr>
<tr>
<td>%</td>
<td>20,800</td>
</tr>
</tbody>
</table>

2. **Field Testing.** Conduct field testing during the first production day at three locations selected by the Engineer. Provide adequate notice to allow the Engineer to witness this field testing. Use a tension testing device in accordance with ASTM E 488. Provide a copy of a certified calibration for the tension testing device. Update the calibration annually. Ensure field tests show the anchor provides a pull-out resistance of at least 50 percent of the proof tensile load at 1/16 inch slippage. The Engineer may conduct random pullout tests at 50 percent of the proof tensile load, for acceptance.

L. **Mechanical Reinforcement Splicing.**

1. **Preparation of Bar Ends.** Saw or shear bars requiring splicing. Straighten the ends of sheared bars. Remove burrs, paint, oil, rust, scale, or other deleterious material from surfaces. Use wire brushes, abrasive blasting, or other Department-approved methods to clean 2 inches beyond sleeve locations immediately before splicing. Obtain the Engineer’s approval for bar end surface preparations before installation.
2. **Installation.** Install reinforcement splices in accordance with the manufacturer’s procedure. Submit the installation procedure, including manufacturer approvals, to the Engineer for review before beginning splicing.

If using epoxy coated steel reinforcement, epoxy coat mechanical reinforcement splices in accordance with AASHTO M 284. If the installation procedure does not damage a pre-applied epoxy coating, provide epoxy coated splices. After installation, epoxy coat exposed surfaces of mechanical reinforcement splices and attached reinforcing steel, including damaged coatings and exposed threads, in accordance with subsection 706.03.E.8.

Protect the threads of threaded couplers with internal plastic coupler protectors, or other manufacturer-approved methods. Protect the threads on the reinforcing bars with plastic bar end protectors, or other Department-approved methods. Adjust flanged or asymmetrical couplers to minimize infringement on the required clear cover.

3. **Testing.** For swaged splices, make five test splices on the smallest and five test splices on the largest bar sizes. Provide adequate notice to allow the Engineer to witness the test splicing. Use tests to establish a splicing procedure. For other types of splices, provide two test splices on the largest bar sizes. Demonstrate to the Engineer that splices have a tensile strength of 125 percent of the bar yield strength. For required tests, provide sample bars, 12 inches long. If the exterior of existing reinforcing steel for splicing is corroded or deformed, the Engineer may require additional qualification testing on the bars. The Department will test all test splices.

M. **Forming.** Provide forms to enable placement of concrete mixture. If approved by the Engineer, suspend forms from existing reinforcing bars using wire ties. In large removal areas, support forms by blocking from the beam flanges. Install forms for vertical patches in no greater than 4-foot high sections, with the form tops no more than 4 feet above the concrete level as the pour progresses. Remove forms upon completion of the work.

N. **Protection and Cleaning of Deck Areas to be Overlaid.** Maintain areas of removed unsound concrete and patches, free of slurry produced by wet sawing or wet scarifying. Conduct the work to ensure slurry drains away from completed areas. Remove slurry from prepared areas before resurfacing.
Before placing overlay, blast clean the deck and the edges of previously placed overlays to expose coarse aggregate and obtain a sound surface for bonding the overlay to the deck. Blast clean with abrasive or water under high pressure.

Control dust from abrasive blasting operations, as determined by the Engineer. Dust control may include the use of a cleaner abrasive or switching to water-blasting equipment for dust control.

Complete the final deck preparation and allow the Engineer time to inspect the deck condition before placing overlay. Obtain written approval from the Engineer for placing concrete overlay.

Do not allow traffic on the prepared deck before overlay placement.

Clean and wet the deck surface 1 hour before placing overlay mixture and keep surface damp throughout the pour. Remove standing water from depressions, holes, or concrete removal areas with oil-free compressed air.

O. Mixing, Placing, Finishing, and Curing Concrete Patches. Machine mix patching mixture with equipment specified in subsection 703.03.B. Provide mixture in quantities to allow placing and finishing before initial set.

Moisten surface without leaving free water, and prime the existing concrete. Place patching mixture.

On bridge decks with latex modified concrete mixes, use a stiff bristle brush to apply the initial layer of mixture onto the wetted, prepared surface and ensure vertical and horizontal surfaces receive an even coating. Limit the rate of progress so brushed material does not dry before covering with overlay material. Do not use material for brushing if no mortar remains in the mix.

For bridge decks, place the patching mixture into the area, vibrate uniformly, and finish with a wood float. After finishing, texture the patched surface to uniformly roughen the surface.

For patches on surfaces other than decks, place concrete and consolidate. The Engineer may direct the use of small hand vibrators or the vibration of the forms.

Immediately after final finishing of each patch, apply a layer of wet burlap, soaked in water for at least 12 hours, to exposed concrete surfaces. Place a 4-mil thick layer of polyethylene film over the burlap to protect the top surfaces from evaporation.
The Contractor may use membrane curing compounds for patches of non-latex modified concrete. The Contractor may leave forms in place, with burlap covering exposed areas, for curing.

Keep patches of non-latex modified concrete, covered until concrete attains a flexural strength of 550 psi, but no less than 5 days for regular strength patching mixtures, or no less than 24 hours for high-early-strength patching mixtures.

Maintain patches with regular strength latex modified concrete, continuously damp for the first 48 hours. Remove curing material at the end of the 48 hour wet cure period and allow concrete to air cure for an additional 48 hours. Maintain patches with high early strength latex modified concrete continuously damp for at least 24 hours.

If the air temperature falls below 50 °F, the Engineer may require additional curing time to ensure concrete attains a flexural strength of 550 psi. If completing concrete repairs in cold weather, protect concrete in accordance with subsection 712.03.R.

Do not place additional concrete on substructure concrete until substructure concrete cures for at least three days, or attains at least 70 percent of the required minimum 28-day flexural or compressive strength. Do not use mechanical attachments to substructure concrete to support forms until concrete attains at least 70 percent of the required minimum 28-day flexural or compressive strength.

Verify existing concrete strength by testing at least two beams or cylinders cured in the same environment as the sampled concrete. Conduct testing on the project. Provide adequate notice to allow the Engineer to witness the testing. The Engineer will lower the required concrete strength after reviewing engineering calculations submitted by a professional engineer licensed in the state of Michigan showing that imposed loads do not exceed 70 percent of the concrete strength at the time of load application.

P. Mixing, Placing, Finishing and Curing Latex Modified Concrete Overlay Mixtures. Keep equipment off patches until patches attain a flexural strength of at least 550 psi.

Form expansion joints and dams through the overlay. Install bulkheads to the required grade and profile before placing concrete mixture. Do not cast full depth across the joint.

Place screed rails and fasten to ensure finishing new surfaces to the required profile. Provide horizontally and vertically stable supporting rails. Do not treat screed rails with parting compound. Remove and
reinstall portions of existing thrie beam guardrail required for access to screed the deck.

Texture and finish deck surfaces to the tolerances specified in subsection 706.03.M.3 and subsection 706.03.M.4.

Proportion ingredients, and mix at the project in clean mixers. Provide concrete, uniform in composition and consistency. Produce mix at a rate that allows finishing to continue at a steady pace with final finishing completed before the formation of the plastic surface film. Brush the initial layer of mixture onto the wetted, prepared surface and ensure vertical and horizontal surfaces receive an even coating. Limit the rate of progress so brushed material does not dry before covering with overlay material. Do not use material for brushing if no mortar remains in the mix.

Place the mixture at least ¼ inch above the final grade. Consolidate and finish to the final grade. Hand finish with a float along the edge of the pour, or on small areas. Use a small quantity of latex grout to aid hand floating, if necessary. Finish joints with an edge tool, except next to metal expansion dams, curbs, previously placed lanes, and edges requiring sawing. Grind to remove minor irregularities.

After the mixture stiffens, separate screed rails and construction bulkheads from the new material by passing a pointing trowel along the inside face. Cut with the trowel the entire depth and length of rails. Do not separate metal expansion dams from the overlay.

Cover the finished surface with a single layer of clean, wet burlap when the surface can support it without deformation.

Place polyethylene film, at least 4 mils thick on the wet burlap within 1 hour of covering the concrete with burlap and wet cure the surface for 48 hours.

If the Engineer approves, the Contractor may substitute burlap-polyethylene sheets for polyethylene film. Place polyethylene side down, against the wet burlap.

At the end of the 48-hour wet cure period, remove curing material and allow the surface to air cure for an additional 48 hours. Do not allow curing water runoff to enter surface water.

Q. Mixing, Placing, Finishing, and Curing SFMC Concrete Overlays. Keep equipment off patches until patches attain a flexural strength of at least 550 psi.
Form expansion joints and dams through the overlay. Install a bulkhead to the required grade and profile before placing the concrete mixture. If joint placement is integral with overlay placement, cast joints full depth.

Place screed rails and fasten to ensure finishing new surfaces to the required profile. Provide horizontally and vertically stable supporting rails. Do not treat screed rails with parting compound. Remove and reinstall portions of existing thrie beam guardrail required for access to screed the deck.

Appoint a technical representative, capable of adjusting SFMC batching and mixing. The technical representative will designate a batching sequence to ensure uniform distribution of material throughout the SFMC mixture. Ensure the technical representative is present at the trial batch and the first day of SFMC placement to make recommendations and adjust the mixture.

Mix and place a 4 cubic yard trial batch at the batch plant, or at the project as directed by the Engineer, at least 3 working days before full production. Notify the Engineer of the time and location of the trial batch at least 24 hours before batching.

Proportion trial batches in accordance with the adjusted mix design, using the same materials as in the production mixture. The Engineer will consider the trial batch successful if slump test results are within 1 inch of the required range, and the air content test results are within 1.0 percent of the required range. If trial batches do not meet the requirements, discard and repeat the batching at no additional cost to the Department.

Proportion and mix SFMC using a ready mixed or central mixed batch plant in accordance with subsection 701.03. Discharge trucks on the project within 1 hour of charging at the plant.

Wet the prepared deck, 1 hour before placing the SFMC overlay, with a spray application of water. Use clean, oil free, compressed air to remove water collected in depressions.

Hand vibrate SFMC mixture placed in localized areas deeper than 3 inches. Draw a probe vibrator horizontally through the concrete, parallel to the transverse reinforcing bars, at intervals no greater than 18 inches. Vibrate ahead of the finishing machine. Provide a locator system to assist the operator in finding deep removal areas, and coordinate with the Engineer.

Texture and finish deck surfaces to the tolerances specified in subsection 706.03.M.3 and subsection 706.03.M.4.
Apply a continuous fog spray of water to screeded and finished concrete. Provide fogging equipment capable of spreading a fine mist over concrete surfaces without ponding water. Continue fogging behind the final floating operation until placement and activation of the wet cure system. Do not fog concrete surfaces to aid surface finishing.

Prepare clean, contaminate-free burlap by soaking in clean water for at least 12 hours before beginning concrete placement. Immediately before use, drape or suspend the burlap sheeting vertically to remove excess water. Cover concrete surfaces with wet burlap when the concrete surface can support it without deformation. Do not allow in-place burlap to dry. Do not use Burlene, or other products with impervious surfaces.

Install a network of soaker hoses over wet burlap when the concrete surface will support it without deformation. Use soaker hoses perforated throughout the lengths, within the curing limits. Use non-perforated hose outside the curing limits. Connect to a water supply that meets the requirements of section 911. Ensure soaker hoses apply cure water uniformly and continuously cover the entire bridge deck surface without moving the hoses. Prevent excessive localized water discharge. Demonstrate to the Engineer that soaker hose systems provide uniform coverage of the entire deck surface.

Place a layer of 4 mils thick polyethylene film over the entire deck surface and soaker hose system. Overlap seams in the polyethylene at least 10 inches. Activate the system and maintain to ensure complete and uninterrupted wet curing. Control water runoff to prevent hazard to traffic or soil erosion. Do not allow curing water runoff to enter surface waters.

Maintain the wet cure for at least seven days after concrete placement. Do not remove wet cure systems, based on 7-day compressive strengths reached in less than 7 days.

R. Cold Weather Limitations for Placing SFMC or LMC Overlay Mixtures. Complete overlays and other work within required temperatures. Do not place LMC or SFMC concrete after November 1.

Place overlay mixtures if the air temperature and concrete substrate are at least 40 °F and rising, and the forecast air temperature, during the curing period will remain above 35 °F. Use insulating blankets if the forecast air temperature, during the curing period will fall below 45 °F. Overlap blankets at least 12 inches. Place the insulating blankets on top of the wet curing system. Leave insulating blankets in place for the duration of the wet curing period.
If the forecast air temperature will fall below 45 °F during the remainder of the curing period, provide beams from each pour day to allow the Engineer to determine when concrete overlay attains a flexural strength of at least 550 psi. Cure for the full curing period, regardless of strength gain.

S. **Hot Weather Limitations for Placing Overlay Mixtures.** Cast concrete overlay mixtures when evaporation does not exceed 0.15 pounds per square foot per hour in accordance with Figure 706-1. Cast overlay concrete when air temperature remains below 85 °F. Supply Department-approved equipment for determining the relative humidity and wind velocity on the project.

T. **Construction Limitations for Placing Overlay Mixtures.** For delays no greater than 1 hour, protect the end of the concrete pour from drying with several layers of wet burlap.

For delays greater than 1 hour, install a construction dam or bulkhead. If restarting the overlay placement before the concrete cures, leave a 3-foot gap between bulkheads. Blast clean and cast the gap the next working day.

Protect freshly placed concrete from rain, as approved by the Engineer. Stop placement operations if rain starts. The Engineer may direct the removal of material damaged by rain.

For LMC overlays, keep traffic off the surface for at least 96 hours after placement. At temperatures below 55 °F, the Engineer may require additional dry curing.

Complete the continuous 7-day wet cure of SFMC overlays before casting sidewalk, curb, or barrier. Allow heavy equipment on the deck overlay only after the overlay concrete is in place at least 7 days.

Remove screed rails after the concrete takes initial set. Protect edges of new surfaces from damage during screed rail removal.

Cure overlays and repair areas for at least 48 hours before scarifying, hydrodemolition, or chipping within 6 feet. Outline repair areas with saw cuts extending to the depth of the overlay before removal and repair.

U. **Repairing Cracks by Pressure Injection.** Repair cracks as shown on the plans or directed by the Engineer.

1. **Preparation of Cracked Surfaces.** Remove leaching deposits from cracks by abrasive blasting or wire brushing, as directed by the Engineer. Apply a temporary seal, with entry ports for adhesive, along the clean, dry crack without defacing the concrete surface.
Ensure the seal contains the pumped adhesive. Spaces ports farther apart than the estimated crack depth and close enough to allow adhesive material to travel between ports.

2. **Flushing Cracks.** If directed by the Engineer, flush cracks with water by pressure washing through injection ports. Wash out concrete laitance or contaminants in the crack. Remove free water by blowing air through the crack after flushing.

3. **Temperature Limitations for Injection.** Perform injection when concrete and ambient air temperatures are above 50 °F. The Engineer may approve lower injection temperatures if the adhesive material manufacturer’s recommendations support lower injection temperatures.

4. **Injection of Cracks.** Begin injection at the lower entry port and continue until adhesive is visible at the port directly above, or next to the pumping port. Stop injection and seal the port. Transfer the injector to the next port and continue injection until the crack fills. Inject from both sides of a cracked member to complete crack repair. Prevent leakage of the adhesive from the crack after injection completion.

5. **Adhesive Cure and Removal of Temporary Seal.** Cure adhesive at temperatures of at least 50 °F for the minimum cure time recommended by the manufacturer. Remove the seal or grind flush with the concrete surface. The Engineer may allow the temporary seal to remain in place for injected areas not visible.

   Clean areas repaired by injection of surface contamination caused by injections.

V. **Water Repellent Treatment.** Apply penetrating water repellent treatment in accordance with subsection 706.03.S.

W. **Cleaning and Coating Exposed Structural Steel.** Clean and coat areas of visible rust, rust breakthrough, and blistered, peeling, or scaling paint as identified by the Engineer. Clean structural steel exposed during concrete removal in accordance with SSPC-SP3 Power Tool Cleaning, and brush coat with 5 mils to 10 mils of aluminum-filled epoxy mastic; or clean and coat in accordance with section 715. Protect the work and environment in accordance with section 715. The Engineer will inspect the following surfaces to decide the necessity of cleaning and coating:

   1. The tops and edges of top flanges, and beam ends if removing the entire deck above steel beams;
2. The edges of top flanges if using metal deck forms; and
3. Metal surfaces exposed during removal of backwall portions or full
deck removal.

X. **Grouting Under Masonry Plates.** Propose procedures for grouting
under masonry plates to the Engineer for approval. Demonstrate to the
Engineer by full-scale test, that the grout placement procedures result in
90 percent surface area contact, based on the contact areas of the
masonry plate and concrete surface.

Do not begin the grouting operation until underlying concrete achieves
the required compressive strength.

Form the space for grouting and clean the surface. Mix, place, and cure
grout in accordance with the manufacturer's recommendations.

After curing, remove forming material to allow inspection of the grouted
space. Do not apply load to the grout until cure completion.

Y. **Galvanic Anodes.** Use portland cement-based repair mortars,
concrete, and bonding agents. Do not use non-conductive repair
materials, including epoxy, urethane, or magnesium phosphate.

Install galvanic anodes to existing, uncoated reinforcement along the
perimeter of the repair, spaced as shown on the plans. Ensure the
distance between anodes does not exceed 24 inches.

Provide ¾-inch clearance between anodes and substrate to allow repair
material to encase anodes.

Secure galvanic anodes as close as possible to the patch edge using
anode tie wires. Tighten tie wires to prevent free movement.

If tying anodes onto a single uncoated steel reinforcing bar, or if covering
with less than 1½ inches of concrete, place anodes under the uncoated
reinforcing steel. Secure anodes to uncoated reinforcing steel per
manufacturer's recommendations.

If 1½ inches of concrete covers the anode, the Contractor may place
anodes at the intersection between two uncoated bars, and secure to
each bar.

Confirm electrical connection between anode tie wires and uncoated
reinforcing steel with a multi-meter. Ensure a direct current (DC)
resistance of no greater than 1 ohm.

Confirm electrical continuity of exposed, uncoated reinforcing steel in the
repair area. The Department will consider steel reinforcement
continuous if the DC resistance equals no greater than 1 ohm. If the DC
resistance is greater than 1 ohm, establish electrical continuity with uncoated steel tie wire.

Obtain verification of installation of galvanic anodes from the Engineer before concrete placement.


<table>
<thead>
<tr>
<th>Pay Item</th>
<th>Pay Unit</th>
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<tr>
<td>Bridge Joint, Revise Expansion Device</td>
<td>Each</td>
</tr>
<tr>
<td>Bridge Joint, Revise Compression Seal</td>
<td>Each</td>
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<tr>
<td>Adhesive Anchoring of Vertical Bar, ___ inch</td>
<td>Each</td>
</tr>
<tr>
<td>Adhesive Anchoring of Horizontal Bar, ___ inch</td>
<td>Each</td>
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<tr>
<td>Bolt, Adhesive Anchored, ___ inch</td>
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<tr>
<td>Bolt, Mechanical Expansion Anchored, ___ inch</td>
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<tr>
<td>Reinforcement, Mechanical Splice</td>
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<td>Patch, Full Depth</td>
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<td>Patching Mortar of Conc</td>
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<tr>
<td>Patching Conc, (type)</td>
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<td>Bridge Joints, Clean and Seal (Structure No.)</td>
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<td>Flushing Cracks, Water</td>
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<td>Top Flanges and Beam Ends, Clean and Coat</td>
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<td>Conc, Silica Fume Modified</td>
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<td>Conc, Bridge Deck Ovly</td>
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<td>Masonry Plate, Grout</td>
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<tr>
<td>Embedded Galvanic Anode</td>
<td>Each</td>
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</tbody>
</table>

A. **Scarifying.** The Engineer will measure **Scarifying** to the limits shown on the plans, including joints and drain castings.
B. **Latex Concrete Surface, Removal.** The unit price for **Latex Concrete Surface, Rem** includes the cost of removing latex modified concrete bridge deck surfaces to a depth of 3 inches or to the top mat of steel reinforcement. The Department will pay for removing unsound latex modified concrete at or below the top mat of steel reinforcement at the unit price for relevant hydrodemolition pay items.

C. **Hand Chipping.**

1. **Hand Chipping, Shallow.** **Hand Chipping, Shallow** applies to removing bridge deck concrete from the surface to the midpoint of the top bar of the top mat of the steel reinforcement. The Engineer will measure **Hand Chipping, Shallow** based on areas marked by the Engineer. The unit price for **Hand Chipping, Shallow** includes the cost of blast cleaning steel reinforcement and preparing the area for patching.

2. **Hand Chipping, Deep.** **Hand Chipping, Deep** applies to removing bridge deck concrete to expose steel reinforcement, from the surface to at least ¾ inch below the bottom of exposed steel. The Engineer will measure **Hand Chipping, Deep** based on areas marked by the Engineer. The unit price for **Hand Chipping, Deep** includes the cost of blast cleaning steel reinforcement, preparing the area for patching, cleaning and coating exposed structural steel, and protecting the work and the environment during cleaning.

3. **Hand Chipping, Other Than Deck.** **Hand Chipping, Other Than Deck** applies to removing concrete, but does not apply to removing deck top surfaces, regardless of depth. The Engineer will measure **Hand Chipping, Other Than Deck** based on areas marked by the Engineer. The unit price for **Hand Chipping, Other Than Deck** includes the cost of blast cleaning steel reinforcement and preparing the area for patching.

4. **Hydrodemolition.** The Engineer will measure **Hydrodemolition, First Pass** to the limits shown on the plans, including expansion devices and drain castings.

The unit price for **Hydrodemolition, First Pass** includes the cost of removing concrete, including concrete removed during the successful hydrodemolition equipment demonstration, tying exposed steel reinforcement, cleaning and coating exposed structural steel, and protecting the work and the environment during cleaning.

The unit price for **Hydrodemolition, Second Pass** includes the cost of hand chipping to remove concrete, including latex modified concrete, below steel reinforcement.
The Department will pay for removing HMA patches as HMA Patch, Rem in accordance with subsection 501.04.

D. Reinforcing.

1. Reinforcement, Steel. The Engineer will measure, and the Department will pay for reinforcing steel as Reinforcement, Steel in accordance with subsection 706.04. The Engineer will measure dual bars of equivalent section as the required size.

The unit price for Reinforcement, Steel includes the cost of providing and splicing in new bars to replace corroded or removed bars. The Department will not pay for replacing reinforcement damaged by Contractor operations.

2. Adhesive Anchoring of Vertical and Horizontal Bars. The unit prices for Adhesive Anchoring of Vertical Bar and Adhesive Anchoring of Horizontal Bar, of the sizes required, includes the cost of providing adhesive, drilling and cleaning holes, filling holes with adhesive, installing bars, and testing.

The unit price for Reinforcement, Steel includes the cost of providing reinforcing bars.

The Department will pay for each bar end requiring anchoring as a separate unit.

3. Reinforcement, Mechanical Splice. The Engineer will measure, and the Department will pay for Reinforcement, Mechanical Splice by the number of units required. If increased coupler lengths compensate for inferior deformations on existing bars, the Department will increase the unit price on a pro-rated basis, based on the length of the increase in inches.

The unit price for Reinforcement, Mechanical Splice includes the cost of preparing test samples, preparing steel reinforcement for splicing, installing couplers, and applying epoxy coating.

The unit prices for Reinforcement, Steel and Reinforcement, Steel, Epoxy Coated, include the cost of threaded reinforcing bars used with threaded couplers.

E. Bolt, Adhesive Anchored. The unit price for Bolt, Adhesive Anchored includes the cost of providing bolts and adhesive, drilling and cleaning holes, filling holes with adhesive, installing bolts and testing.

The unit price for Bolt, Mechanical Expansion Anchored includes the cost of testing.
F. **Structures, Rehabilitation, Remove Portions.** The unit price for **Structures, Rehabilitation, Rem Portions** includes the cost of removing materials as shown on the plans, saw cuts required for removal, and disposal of materials in accordance with subsection 204.03.B.

G. **End Header Replacement.** The unit price for **End Header Replacement** includes the cost of removing and replacing end headers, decks, backwalls, and approach pavements as shown on the plans.

H. **Structural Crack, Repair.** The Engineer will measure **Structural Crack, Repr** along the length of crack injected, along one surface only. The unit price for **Structural Crack, Repr** includes the cost of preparing cracks, installing temporary seals and ports, providing and injecting the epoxy adhesive, removing temporary seals, and cleaning finished surfaces.

If the Engineer requires additional cleaning and flushing of the cracks, after placing temporary seals and entry ports, the Department will pay for this work as **Flushing Cracks, Water.**

I. **Deck Joint, Removal.** The Engineer will measure **Deck Joint, Rem** to the limits shown on the plans. The unit price for **Deck Joint, Rem** includes the cost of removing expansion and construction joints, cleaning and coating exposed structural steel, removing deck joint concrete, regardless of deck thickness and diaphragm locations, protecting the work and environment during cleaning, and removing and reinstalling portions of existing thrie beam guardrail required to remove the joint. The Department will pay for removal required beyond the limits shown on the plans as extra work.

**Bridge Deck, Joint Revise Expansion Device** and **Bridge Joint, Revise Compression Seal** will be measured as each. The Engineer will measure each joint end separately.

J. **Patching.** The Engineer will measure **Patch, Full Depth** based on the volume of the hole requiring filling. The unit price for **Patch, Full Depth** includes the cost of forming, providing, placing, consolidating, finishing, and curing patching mixture.

If using **Patch, Full Depth** in conjunction with overlay, the Department will only pay for patching the area shown on the plans. If full depth patches are required in areas not shown on the plans unit prices for **Conc, Bridge Deck Ovly** or **Conc, Silica Fume Modified** will include the cost of the concrete material required to fill the full depth patches.
For full depth patches, not shown on the plans, the Department will pay for cleaning and coating exposed structural steel, forming (excluding forming required for joint replacement), form removal, and cleanup as extra work. The Department will pay for maintaining traffic under the structure to repair the full depth patch as extra work.

The Engineer will measure **Patching Mortar or Conc** or **Patching Conc**, regardless of the type of mortar or concrete, by volume in place. The unit prices for **Patching Mortar or Conc** or **Patching Conc** include the cost of providing, mixing, placing, vibrating, finishing and curing.

The contract will specify the grade or type of patching material for **Patching Conc** pay items.

The Engineer will measure **Patch, Forming** based on the area of removed concrete. The unit price for **Patch, Forming** includes the cost of forming to retain patching material, except on full-depth patches on bridge decks.

**K. Bridge Decks.**

1. **Bridge Deck Surface Construction.** The Engineer will measure **Bridge Deck Surface Construction** within the limits shown on the plans, including expansion devices and drain castings in accordance with subsection \(706.04\). The unit price for **Bridge Deck Surface Construction** includes the cost of blast cleaning decks, and consolidating, finishing, texturing, and curing surfacing mixtures, and removing and reinstalling portions of existing thrie beam guardrails required for access to screed the deck.

2. **Concrete, Silica Fume Modified.** The Engineer will document quantities of **Conc, Silica Fume Modified**, and measure based on batch plant tickets with deductions for material wasted or rejected. The unit price for **Conc, Silica Fume Modified** includes the cost of providing and placing overlay concrete on prepared deck substrate, the initial 4-cubic-yard trial batch, and providing insulating blankets.

   The Department will not pay for trial batches after the initial 4-cubic-yard trial batch.

3. **Concrete, Bridge Deck Overlay.** The Engineer will document the quantity of Silica Fume Modified Concrete Mixture (SFMC) and measure based on batch plant tickets with deductions for material wasted or rejected. The unit price for **Conc, Bridge Deck Ovly** includes the cost of providing and placing overlay concrete on prepared deck substrate, within the limits shown on the plans, and the initial 4-cubic-yard trial batch.
The Department will not pay for trial batches after the initial 4-cubic-yard trial batch.

The Engineer will measure the quantity of Latex Modified Concrete (LMC) mixture by the surfacing mixture volume used for the partial-depth patching and overlay. The Engineer will determine the quantity from the theoretical yield of the design mix and the quantity documented on the ticket printout for cement placed and yield tests performed, and will make deductions for material wasted or rejected.

The unit price for **Conc, Bridge Deck Ovly** includes the cost of providing and placing surfacing mixture, and insulating blankets.

L. **Top Flanges and Beam Ends, Clean and Coat.** The Engineer will measure **Top Flanges and Beam Ends, Clean and Coat** based on the limits shown on the plans or determined by the Engineer. The unit price for **Top Flanges and Beam Ends, Clean and Coat** includes the cost of cleaning and prime coating top flanges and beam end areas, and protecting the work and environment during cleaning.

M. **Filler Wall Concrete.** The Engineer will measure **Filler Wall Conc** based on plan quantities. The unit price for **Filler Wall Conc** includes the cost of forming walls with weepholes and forming footings with drain holes; providing, placing, finishing, and curing concrete for filler-walls, footings, and filler wall extensions; providing and placing expansion joint filler, granular material Class II, and 4-inch concrete slab between walls; and covering drain holes with geotextile.

N. **Embedded Galvanic Anodes.** The unit price for **Embedded Galvanic Anodes** includes the cost of installing anodes in concrete. The Department will pay the Contractor after the Engineer verifies installation as required.