

**SECTION 509**

**MICROSILICA MODIFIED CONCRETE OVERLAY**

**509-1.01 DESCRIPTION.** Furnish and install microsilica modified concrete (MMC) overlay, as specified, at the location(s) shown in the Plans.

**509-2.01 MATERIALS.** Use materials that conform to the following:

- |                          |   |
|--------------------------|---|
| Portland Cement          | Section 701- <a href="#">2.01</a> (Type I or Type IA)   |
| Fine Aggregate           | Subsection 703-2.01   |
| Coarse Aggregate         | Quality: Subsection 703-2.02<br>Gradation: AASHTO M 43 (Gradation No. 7)  |
| Sand For Abrasive Finish | Crushed sand, oven dried, and stored in moisture-proof bags. Meet the following gradation requirements when tested according to WAQTC FOP for AASHTO T 27/T 11: |

Sieve	Percent Passing
No. 8	100
No. 30	97-100
No. 200	0-5

- |   |                               |
|---|-------------------------------|
| High Molecular Weight Methacrylate (HMWM) Resin | Subsection 705-2.06           |
| Microsilica Admixture                           | Subsection 711-2.04           |
| Epoxy Resin Mortar                              | AASHTO M 235, Type I, Grade 3 |

**CONSTRUCTION REQUIREMENTS**

**509-3.01 [CONTRACTOR QUALITY CONTROL, AND DEPARTMENT QUALITY ACCEPTANCE AND TESTING.](#)**

1. Technical Representative. Have a technical representative from the microsilica admixture manufacturer present during initial proportioning, mixing, placing and finishing operations. The technical representative must:
  - a. Remain on site for at least the first 2 days of placement.
  - b. Be able to perform, demonstrate, inspect and test all of the functions required for placing the MMC as specified and approved by the Engineer.
  - c. Aid in properly installing the MMC.

Adhere to recommendations made by the technical representative as approved by the Engineer.

2. Contractor Test Slab. Make a trial batch of the ~~MMC~~ MMC, which meets the Specifications at least 4 days before placing the first section of the overlay. Make the trial batch the same size to be batched per truck. Place a test slab at a location approved by the Engineer. Cast the slab 12 feet wide, the same thickness of the overlay, and long enough to place the trial batch. Furnish individual batch weights to the Engineer. Finish and cure the test slab according to all the requirements of these Specifications.

Notify the Engineer 7 days before preparing the test batch. The Engineer will sample for slump, air entrainment and unit weight and conduct all the required tests to determine if the MMC meets specifications before field placement.

The test slab remains the Contractor's property. Remove and dispose of the test slab after testing is complete.

3. Department Acceptance~~Production~~ Testing. The Engineer will perform the following tests:
  - a. Daily Start-up Tests. Slump and entrained air tests according to WAQTC FOPs for AASHTO T 119 and T 152, respectively, on each of the first two loads of each day before the concrete is placed. Discharge and set aside a wheelbarrow load of concrete for this purpose.
  - b. Operational Control Tests. Slump and entrained air tests for concrete on random samples, selected according to AASHTO T 141, with at least one set of tests for every 20 cubic yards.
  - c. Quality Assurance~~Acceptance~~ Tests. Compressive strength and permeability tests. The Engineer will select the concrete specimens and perform permeability tests according to AASHTO T 277 for concrete samples aged to 28 days. The charge passed through the sample must not exceed 1000 coulombs.

d. Placing, Curing, Protecting, Grinding and Grooving. The Engineer will visually inspect measures taken to complete the work. The Engineer may perform tests after curing to verify the concrete meets specifications.

Remove and dispose of test samples when testing is complete. If a test sample does not meet specification requirements, stop production and correct the mix.

Concrete that does not meet specifications may be rejected by the Engineer, and the Contractor must remove the concrete and replace it with new concrete at no extra cost to the Department.

**509-3.02 SUBMITTALS.** Submit a list of proposed materials to be used in the mix, 20 days before placement. Do not begin placing concrete without written approval from the Engineer. Use a mix design according to Subsection 509-3.03.

If hydrodemolition work occurs, include work in the SWPPP according to Section 641, and submit a Wastewater Treatment Plan according to Subsection 510-3.04 before the preconstruction meeting.

**509-3.03 PROPORTIONING MATERIALS.** Mix the concrete into a workable mix that is uniform in composition and consistency and within the proportioning tolerances in Subsection 501-3.01. Use the following mix proportions per cubic yard:

Portland cement	660 lb.
Microsilica Fume	52 lb.
Fine aggregate	<u>45-50%</u> (determined from mix design)

Coarse aggregate	<u>50-55%</u> (determined from mix design)
Air	6% ±1.5%
Water/cement ratio	0.33 lb./lb. max.

Calculate the water/cement ratio using all of the available mix water, including the free water in both the coarse and fine aggregate and in the microsilica slurry, if a slurry is used.

Mix the concrete to a maximum slump of 7 inches. Adjust the slump to accommodate the gradient of the deck. Add water-reducing admixtures, air-entraining admixtures, and superplasticizers according to the microsilica admixture supplier's recommendations.

**509-3.04 STORAGE OF MATERIALS.** Store materials per Subsection 106-1.06 and the following:

1. Aggregate. Prevent variations of more than 1.0% in the stockpile moisture content.
2. High Molecular Weight Methacrylate (HMWM) Resin. Store the HMWM resin in a cool, dry place. Protect resin from freezing and exposure to temperatures greater than 100 °F. If the promoter and initiator are supplied separately from the resin, store them so that they do not contact each other directly. Do not store containers of promoters and initiators together in a way that allows leakage or spillage from one to contact containers or materials of the other.

**509-3.05 EQUIPMENT.** Use equipment that complies with the applicable requirements of Section 510 and the following:

1. Air Compressor. Equipped with oil traps to eliminate oil from being blown onto the roadway deck during sandblasting and air-cleaning.
2. Vacuum Machine. Capable of collecting all dust, concrete chips, free-standing water and other debris encountered during deck cleaning and preparation. Equipped with collection systems that can operate in air pollution sensitive areas and will not contaminate the deck during final preparation for concrete placement.
3. Water Blast Equipment. High-pressure water blasting equipment capable of removing dust, debris, and loose, disintegrated concrete. Must produce a minimum pressure of 5000 psi.
4. Water Spraying System. A portable high-pressure sprayer with a separate water supply. Make the sprayer readily available to all parts of the deck being overlaid. The sprayer must discharge water in a fine mist to prevent accumulation of free water on the deck. Make sure enough water is available to thoroughly soak the deck being overlaid and keep the deck wet until concrete is placed.

Certify that the water spraying system meets the following minimum requirements:

Pressure	2200 psi
Flow Rate	5 gallons per minute
Fan Tip	15 to 25 degree range

5. Fogging Equipment. Water fogging equipment capable of increasing humidity in the area of placement. Use nozzles that produce a fine fog mist to maintain a sheen of moisture on the overlay surface without ponding. Limit flow rate to approximately 1 gallon per minute. **Use "Fog-it" triple head nozzle by the Fog-it Nozzle Co., San Francisco, CA, or approved equal.**
6. Finishing Machine. A self-propelled finishing machine that:

- a. Can move forward and in reverse under positive control.
- b. Provide for raising and lowering all screeds under positive control. Ensure the upper vertical limit of screed travel permits the screed to clear the finished concrete surface.
- c. Is adjustable to produce the required cross-section, line, and grade. When placing concrete abutting a previously placed lane or strip, ensure the side of the finishing machine is equipped to travel on the completed lane or strip.
- d. Is equipped with a rotating cylindrical double-drum screed not more than 5 feet long, preceded by a vibrating pan. Use a finishing machine with a metal vibrating pan long and wide enough to consolidate the mixture properly. The vibrating frequency of the vibrating pan must be variable with positive control between 3,000 and 6,000 rpm. The Engineer will consider approving a machine with a vibrating pan as an integral part, if it is proposed.

7. Grooving Machine. A self-propelled grooving machine that:

- a. Is equipped with diamond grinding blades and spacers mounted on a multiblade spindle assembly that provides a minimum cutting head width of 22 inches.
- b. Can align the grooves, detect variations in deck surface and automatically adjust the cutting head height to maintain the specified depth.

8. California Profilograph. A profilograph as described in and calibrated according to Parts 1A and 1B of California Test 526. Motive power may be manual or by propulsion unit attached to the assembly.

**509-3.06 DECK PREPARATION.**

1. Clean. Thoroughly clean the lane or strip being overlaid of all loose particles, dust, oil, grease, rust, or other foreign materials that may reduce the bond of new concrete to old concrete.

Use detergent cleaning, water blast, sandblast or another approved method.

2. Protect. Prevent equipment from contaminating the surface with oil or grease before placing the overlay. When using an air supply system for blast cleaning and blowing, ensure there is an oil trap in the air line.

Confine hydrodemolition to areas at least 100 feet from the defined limits of any final cleaning or overlay placement in progress. If the Engineer determines that hydrodemolition is impeding or interfering in any way with final cleaning or overlay placement, stop the hydrodemolition work immediately and move hydrodemolition equipment far enough from the area being prepared or overlaid.

If the water and contaminants from hydrodemolition could flow into the area being prepared or overlaid because of the grade, suspend the hydrodemolition for the first 24 hours of curing time after the concrete is placed.

When final preparation begins, stop removing concrete by mechanical methods and stop cleaning in areas adjacent to a lane or strip being cleaned. Do not resume removing concrete by mechanical methods until placing the concrete and satisfying the curing-time requirement. Suspend sandblasting and cleaning for the first 24 hours of curing time after the concrete is placed.

If the lane or strip being overlaid becomes contaminated after final cleaning, flush the surface with high-pressure water or sandblast (shotblast) the surface before placing the overlay. Begin concrete placement within 24 hours of completing deck preparation for the portion of the deck to be overlaid.

Do not permit traffic (other than required construction equipment) on any portion of the lane or strip prepared for concrete placement, without approval. To prevent contamination from equipment after final cleaning, place polyethylene sheeting over prepared lanes or strips.

3. **Keep Wet.** After cleaning the lane or strip to be overlaid, and at least 6 hours before placing concrete, thoroughly soak the lane or strip with water. Remove all free-standing water. Keep the lane or strip moist until concrete is placed.

#### **509-3.07 BATCHING AND MIXING CONCRETE.**

Batch concrete to conform with Subsection 501-3.03.

Mix concrete to conform with Subsection 501-3.04, but do not use a truckload that contains more than 4 cubic yards of concrete without approval.

#### **509-3.08 FORMS.** Conform with Section 512.

**509-3.09 PLACING CONCRETE.** Before placing concrete, review equipment, procedures, personnel, previous results, and inspection procedures with the Engineer.

Place concrete according to Subsection 501-3.08 and the following:

1. Do not place concrete under the following conditions:
  - a) When the concrete surface temperature is less than 45 °F or greater than 80 °F.
  - b) When the combination of air temperature, relative humidity, fresh concrete temperature, and wind velocity at the construction site produces an evaporation rate of 0.15 lb/ft<sup>2</sup> per hour as determined from Table 501-2.
  - c) When rain is expected. Protect freshly placed concrete in case rain begins during placement. Remove and replace rain-damaged concrete to the satisfaction of the Engineer.
2. Use enough concrete delivery trucks to deliver and place concrete consistently and continuously throughout the pour. Finishing machines must move continuously without stopping, and the concrete supply must be adequate to supply the machine. Use two vibrators, one on the finishing machine and one to vibrate the edges and joints.
3. Use bulkheads for all joints. Before placing concrete against previously placed concrete, check the joint for bond. Remove and replace unbonded concrete as specified in Subsection 509-3.13.
4. If concrete placement is stopped for one half hour or more, install a bulkhead transverse to the direction of placement at a position where the overlay can be finished full width up to the bulkhead. Install the bulkhead at full depth of the overlay and to grade. Finish and cure concrete according to these Specifications.

Wait at least 12 hours before placing more concrete, unless there is a gap in the lane or strip. The gap must be wide enough for the finishing machine to clear the transverse bulkhead

installed where concrete placement was stopped. Saw back the previously placed concrete from the bulkhead to straight and vertical edges as designated by the Engineer. Sandblast or water-blast the previously placed concrete before placing new concrete.

5. Do not place concrete against the edge of an adjacent lane or strip less than 36 hours old.
6. Use epoxy resin mortar to patch overhead blow-throughs after placing the overlay.

**509-3.10 FINISHING CONCRETE.** Finish the concrete according to Subsection 501-3.09.3 and the following requirements:

Place rails on which the finishing machine travels outside the area to be overlaid. Use interlocking rail sections or other approved methods of providing rail continuity. Submit plans for anchoring rails for approval according to Subsection 105-1.02. Do not shoot hold-down devices into the concrete unless the concrete is to be subsequently overlaid. Do not penetrate the existing deck with hold-down devices by more than 3/4 inch. Remove rails any time after the concrete has taken an initial set. Protect the new surface edges when removing the finishing machine and rails.

Set screed control to obtain the nominal overlay thickness or specified profile grade and meet finished surface smoothness requirements. The Engineer will verify or adjust the overlay profile before concrete placement. After verifying the profile, the Engineer will not permit changes in the finishing machine elevation controls.

Place and strike off concrete approximately 1/2 inch above the final grade. Consolidate and finish the concrete to final grade with a single pass of the finishing machine to provide a dense, uniform surface. Hand finish concrete to close up or seal off the surface, when required.

Do not allow the concrete surface to dry out. Throughout the finishing process, fog the air over the concrete as needed to maintain a visible moisture sheen on the surface. Use an evaporation reducer, ~~such as "Confilm" by Master Builders, Inc., Seattle, WA,~~ if desired, until the wet burlap is applied.

Separate construction bulkheads from the newly placed concrete, as follows: Pass a pointing trowel along the inside surfaces of the bulkheads. After the concrete has stiffened enough so it does not flow back, carefully make the trowel cut for the entire depth and length of bulkheads.

**509-3.11 CURING CONCRETE.** As the finishing operation progresses, immediately cover the concrete with a single layer of clean, wet burlap. Use burlap cloth that meets the requirements of AASHTO M 182, Class 4 and is no wider than 6 feet. The Engineer will determine if the burlap can be reused, based on its cleanliness and absorption ability.

Make sure the burlap is well drained and laid flat with no wrinkles on the deck surface. Place adjacent strips of burlap with a minimum overlap of 6 inches. Once the burlap is in place, apply a light fog mist of water. Immediately place a separate layer of white, reflective-type polyethylene sheeting over the wet burlap.

Wet cure the concrete by leaving the polyethylene sheeting and burlap in place for at least 72 hours, keeping the burlap wet. Grooving may occur in this period if the Contractor can successfully demonstrate grooving on the test slab, and if the slab doesn't require corrective grinding according to 509-3.14. Groove according to 509-3.15. Wet curing would resume immediately after grooving during the 72 hours.

After the polyethylene sheeting and burlap are removed and the concrete surface has dried, fill and seal all joints and visible cracks with a high-molecular-weight methacrylate (HMWM) resin. Use two applications of HMWM in cracks 1/16 inch and wider. Immediately after applying HMWM, coat the wetted surface with sand for an abrasive finish.

After meeting the curing requirements, use compressed air to accelerate deck-surface drying, crack identification, and sealing.

Do not permit traffic on the finished concrete until the specified curing time is satisfied and the concrete reaches a minimum compressive strength of 3000 psi. Determine compressive strength from informational test cylinders cured on site under temperature and moisture conditions similar to those of the concrete in the structure.

**509-3.12 PROTECTING CONCRETE.** Protect microsilica concrete when placing it in cold weather. Cold weather is defined as when the average daily air temperature for 3 consecutive days is less than 45 °F. The average daily air temperature is the average of the highest and lowest temperatures from midnight to midnight.

After placing MMC, maintain it at a temperature above 50 °F for at least 3 days.

If the air temperature drops below 35 °F while curing, place insulating blankets over the curing materials. Use insulating blankets 2 inches thick with tough, impermeable cover material.

When the deck temperature is lower than 45 °F, pour microsilica concrete only under the following conditions:

1. Use a concrete mixture between 55 °F and 75 °F at the time of placement.
2. If using heated water to obtain proper placement temperatures, add air-entraining agents after the last heated water.
3. Clear the deck of snow, ice, or frost.
4. Maintain the temperature of the deck receiving concrete at 35 °F, minimum.
5. Maintain the temperature of the rebar at 35 °F, minimum.
6. Cover placed concrete with burlap, plastic sheeting and insulated mats immediately after finishing of the surface. Keep the covering in place for 3 days. Monitor concrete temperature hourly for 3 days. Add 1 day to the covered time for any day in which the recorded surface temperature of the concrete is less than 50 °F.
7. If heated enclosures are used, vent combustion heaters to the outside of the enclosure. Locate heaters and ducts to avoid overheating or drying areas of the concrete surface.
8. As an alternative to the requirements of step 6, monitor the slab's compressive strength. Use in-place, non-destructive testing. After 3 days, uncover the concrete, regardless of temperature, when the concrete reaches a compressive strength of 3000 psi.
9. If any freezing temperature is recorded during the first 24 hours that it is covered, promptly remove concrete.

To pour concrete when rain is predicted, observe the following conditions:

- Have materials on hand to cover the work in case of rain.
- Halt the pour and immediately cover all work when rain drops affect the slab finish.

**509-3.13 CHECKING FOR BOND.** After deck curing is complete, the Engineer will test the entire overlaid surface for total bonding of concrete to the bridge deck. Remove concrete from unbonded areas and replace it with MMC without extra compensation.

**509-3.14 SURFACE TOLERANCE.** The Engineer will test the finished surface of the overlay using a straightedge 10 feet long. At your expense, correctively grind all areas where variations in the overlay surface from the testing edge of the straightedge between any two contacts, longitudinal or transverse, exceeds 1/8 inch. After corrective grinding, the Engineer will retest the surface to verify compliance with the specified tolerance.

Furnish and operate a profilograph to test the smoothness of the overlay. Determine the profile index with a California Profilograph recording on a scale of 1 inch or full scale, vertically. Move the profilograph longitudinally along the bridge deck at a speed no greater than 3 mph to minimize bounce.

Take bridge deck profiles 3 feet from and parallel to each edge of each lane. Terminate the profiles 15 feet from each end of the bridge. The Engineer will evaluate the results of the profilograph test in accordance with California Test 526.

Furnish concrete finishing equipment and employ methods capable of producing a bridge deck surface having a profile index of 7 inches per mile or less. At your expense, grind finished surfaces that fail to conform to this smoothness tolerance until the above tolerance is met.

When corrective grinding is necessary, evaluate the bridge deck using the profilograph in sections the length of the bridge or individual spans, if bounded by expansion joints. Within each evaluation section, grind all areas represented by high points having deviations in excess of 0.3 inches per 25 feet. After grinding individual deviations in excess of 0.3 inches per 25 feet, grind to reduce to average profile index to 7 inches per mile or less. Do not reduce the concrete cover on reinforcing steel to less than 1½ inches.

Use an approved grinding machine. Do not use bush hammers or other impact devices. At your expense, re-establish a uniform texture in areas requiring corrective grinding that is as equal as possible to the surrounding, uncorrected, bridge deck.

**509-3.15 GROOVING CONCRETE.** After curing and corrective grinding, groove the deck surface transverse to the centerline of roadway.

Begin transverse grooving one foot from the curb line and run in a continuous pattern to 6 inches from the centerline of roadway for each half of the bridge deck.

Cut grooves 3/16 to 5/16 inches wide by 3/16 to 5/16 inches deep, spaced 1¼ to 1½ inches on center.

**509-4.01 METHOD OF MEASUREMENT.** Section 109 and the following:

MMC overlay pay volume is the difference between the total volume (as indicated by the batch quantity tickets for the ready-mix trucks), minus any remnant, as determined by the Engineer. Remnant includes the volume of MMC remaining in the drum of the last ready-mix truck for each pour.

~~Grooving the deck surface will not be measured for payment.~~

**509-5.01 BASIS OF PAYMENT.** The contract price includes full payment for preparing the existing bridge deck, disposing of the debris, constructing the overlay and finishing, curing, and protecting the surface, as specified.

Overhead patches of hydrodemolition blow-through areas are paid for as specified in the order authorizing the work.

Grooving the deck surface is subsidiary.

Trial batch and test slab are subsidiary.

Payment will be made under:

<b>Pay Item</b>	<b>Pay Unit</b>
509(1) MMC Overlay	Cubic Yard
509(2) Overhead Patches	Contingent Sum