



SECTION 505

BRIDGE DECK CONCRETE WEARING SURFACE

SECTION 505.10 LOW SLUMP CONCRETE.

505.10.1 Description. This work shall consist of constructing a wearing surface of low slump, dense concrete on a prepared surface in accordance with these specifications, as shown on the plans or as directed by the engineer.

505.10.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Type I or II Cement	1019
Air-Entraining Admixture	1054
Water Reducing Admixture	1054
Burlap	1055
Polyethylene Sheeting	1058
Water	1070

505.10.2.1 Coarse aggregate shall be an approved crushed limestone, crushed quartzite, flint chat from the Joplin area or porphyry in accordance with [Sec 1005.2](#), Gradation E, except that the sum of percentages of all deleterious substances shall not exceed one percent and the percentage of deleterious substances shall not exceed the following values:

Item	Percent by Weight
Deleterious Rock	1.0
Shale and Pyrite	0.2
Chert in Limestone	0.5
Other Foreign Material	0.1

505.10.2.2 Gradation D may be used when the plan thickness of the bridge deck overlay is 3 inches or greater.

505.10.2.3 Fine aggregate shall be in accordance with [Sec 1005.3](#) and shall be Class A sand in accordance with [Sec 501](#).

505.10.2.4 Pozzolanic material or Portland pozzolan cements shall not be used.

505.10.3 Concrete Mixture.

505.10.3.1 The contractor shall submit a mix design to Construction and Materials meeting the following properties:

Property	Requirement
Air Content, percent (minimum)	5.0
Slump, inches	1/2 ± 1/2
Percent Fine Aggregate as Percent of	50

Total Aggregate by Absolute Volume	
Cement Content, lbs./cubic yard	818 to 827

505.10.3.2 The cement content and percent fine aggregate shall not be changed. If total mixing water, including free water in aggregate and liquid admixtures, varies from design mixing water to cause a change in batch volume of more than two percent, a new mix design will be required.

505.10.3.3 A Type A water-reducing admixture will be required.

505.10.3.4 During placement, the mixture shall be compacted to no less than 98 percent of the standard density.

505.10.4 Testing.

505.10.4.1 Slump will be determined in accordance with AASHTO T 119. The sample for slump testing will be taken at the point of placement in the structure.

505.10.4.2 Air content will be determined by the pressure method in accordance with AASHTO T 152.

505.10.4.3 When required, standard density, unit weight, will be determined in accordance with AASHTO T 121. Standard density will be determined for at least each two hours of concrete production or any time significant fluctuations occur within the range of air content or slump.

505.10.4.4 Compressive strength will be determined from at least two 6- by 12- inch cylinders or from at least three 4- by 8- inch cylinders prepared in accordance with AASHTO T 23 and tested in accordance with AASHTO T 22. One set consisting of two cylinders will be made for 28-day compressive strength from each day's production. Cylinders made for determining when to permit traffic will be made at a frequency determined by the engineer, and will be cured in the near vicinity and in the same manner as the bridge deck.

505.10.4.5 Concrete taken as a sample for testing slump and air content shall be wasted and shall not be placed in the deck. If air content or slump test results are not in accordance with specifications, any concrete represented by those tests and any concrete in the mixer chute shall be wasted, and the necessary adjustments shall be made in the mix design or proportioning devices.

505.10.4.6 When concrete density is specified, in-place density of plastic concrete will be determined in accordance with MoDOT Test Method TM 36. In-place density will be determined at a minimum passing test rate of one per 100 square yards or three per continuous pour, whichever is greater. A nuclear gauge correction factor will be determined at least once for each day of concrete production. Work bridges spanning the plastic concrete shall be provided by the contractor to permit performing nuclear density tests.

505.10.5 Mixing.

505.10.5.1 Concrete shall be mixed in accordance with [Sec 501](#).

505.10.5.2 Mixing time for rotating paddle type mixers shall be a minimum of 60 seconds after all ingredients have been added. All batches shall be mixed approximately the same length of time. Material for a batch of concrete shall not be placed in the mixing drum until the material for the previous batch has been discharged.

505.10.6 Surface Preparation.

505.10.6.1 On new concrete decks, the surface shall be given a very rough texture while still plastic by use of a wire comb or other approved texturing device which will produce a bondable surface acceptable to the engineer.

505.10.6.2 On old existing concrete decks with existing wearing surfaces, the wearing surface shall be removed in accordance with [Sec 216](#). On existing concrete decks without existing wearing surfaces, the surface shall be scarified in accordance with [Sec 216](#).

505.10.6.3 The textured or scarified deck shall be sandblasted followed by an air blast. The sandblast shall remove all dirt, oil and other foreign material, as well as any unsound concrete or laitance from the surface and edges against which new concrete is to be placed. The compressor shall be equipped to prevent oil in the air supply. That portion of the curb and previously placed overlays against which new concrete is to be placed shall be sandblasted. Any loose or foreign material detected on the concrete surface prior to placement of the overlay shall be removed by sand or air blasting. The concrete surface may require retexturing where penetration of foreign material is evident. No contamination of the retextured or scarified concrete surface will be permitted.

505.10.6.4 To assure that the thickness of the concrete overlay above the prepared surface will be as specified on the plans, the clearance shall be checked in the following manner before concrete is placed. A filler block having a thickness 1/8 inch less than the overlay thickness shall be attached to the bottom of the screed. With screed guides in place, the screed shall be passed over the area to be concreted. Where the intended clearance does not allow use of this method, a stringline or other means shall be used, subject to approval from the engineer. All old concrete that does not have sufficient clearance shall be removed.

505.10.7 Finishing Equipment.

505.10.7.1 The finishing machine shall be designed for striking off and finishing low slump concrete overlay. The machine shall be mechanically powered to operate forward and reverse in a smooth manner, under positive control of the operator. The basic machine shall be of a width to finish a basic 12-foot width of overlay and shall be adjustable for wider placements. The finishing machine shall be designed to allow the screeds to be extended with bolted units to match the extension of the basic unit. The drive wheels shall be of the type that may be replaced with solid rubber wheels to permit travel upon previously completed lanes of overlay when striking off the abutting lanes.

505.10.7.2 The finishing machine shall be equipped with two oscillating transverse screeds. The screeds shall oscillate in a straight line. A swinging pendulum stroke shall not be used. The front screed shall vibrate uniformly for the full length of the screed. The vibrators shall be placed such that the screed vibrates efficiently and the frequency of the vibrators shall be controlled by the operator from the console to achieve the required density.

505.10.7.2.1 Screeds shall be held positive to the machine with rollers and, unless otherwise approved by the engineer, shall be equipped with screed guides such as to control the profile grade of the finished overlay. The screed stroke shall be synchronized to speeds not exceeding 50 strokes per minute, with infinite variable control from the console. The screeds shall be capable of vertical lift when the machine is reversed for travel, and controlled for downward direction to the finishing position to permit feathering of the screeds to any previously finished surface.

505.10.7.2.2 The bottom face of the screeds shall be at least 5 inches wide, with an effective pressure to produce no less than 75 psf. The bottom face of the screeds shall have a turned up leading edge to prevent tearing of the screeded surface and shall be adjustable for tilt and crown. The screed lengths shall be such to produce positive strike off and density of the concrete for at least 6 inches beyond the line where the saw cut for the longitudinal joint is to be made and to within one inch of the curb reinforcing steel or face of any curb barrier already in place.

505.10.7.3 The machine shall be equipped with a mechanically-powered adjustable auger positioned in front of the lead screed. The strike-off shall travel back and forth for the full width to be screeded and shall be properly designed to meter the concrete to the screeds.

505.10.7.4 Heavy duty support rails shall be used to support the finishing machine. Support rails shall be adjustable and the rail shall not deflect more than 1/32 inch between adjustable supports. Support rails shall be placed outside the area and parallel to axis of the area to be concreted. Support rails shall extend a sufficient distance beyond the end of the deck to allow the finishing machine to be completely removed from the deck surface such that hand finishing may proceed without interruption. The support rails shall be set to produce the final profile grade of the surface of the overlay. A hold-down device shot into the concrete will not be permitted unless the concrete is to be subsequently resurfaced. The proposed method of anchoring the support rails shall be submitted to the engineer for approval.

505.10.8 Placing and Finishing Concrete.

505.10.8.1 A lateral support for the concrete such as 2 x 4-inch lumber attached to the deck will be required at least 6 inches beyond the line where the saw cut for the longitudinal joint is to be made.

505.10.8.2 In order to avoid locating the longitudinal construction joints in a wheelpath, the joints shall be placed between the designated traffic lanes. The location of the longitudinal joints shall be subject to the approval from the engineer.

505.10.8.3 At transverse and longitudinal joints, the surface course previously placed shall be sawn to a straight vertical edge before the adjacent course is placed.

505.10.8.4 Transverse joints in the overlay will be permitted if approved by the engineer. These joints shall be located a minimum of 10 feet from the centerline of bent.

505.10.8.5 The contractor shall take every reasonable precaution to secure a smooth riding bridge deck. Prior to placement operations, the contractor shall review with the engineer, equipment, procedures, personnel and previous results as well as inspection procedures to assure coordination. The contractor shall take every reasonable precaution to ensure that concrete can be produced and placed within the specified limits, continuously and with uniformity.

505.10.8.6 The areas of half-sole and full-depth repair shall have individual concrete placement up to bottom of the low slump concrete wearing surface.. These individual placements shall remain rough and shall be completed before the overlay course is started. Areas of half-sole, full-depth repair and all other patched areas shall be surface dried, sandblasted and cleaned prior to the placement of low slump concrete wearing surface.

505.10.8.7 Prior to placement of low slump concrete, the cleaned surface shall be thoroughly wetted for a minimum of three hours, then covered with polyethylene sheeting until the time

of concrete placement. The surface shall be damp at the time the overlay is placed. Any standing water in depressions, holes or areas of concrete removal shall be blown out with compressed air. No free water or puddles of standing water shall exist at the time of placement.

505.10.8.8 The wheels of rubber wheeled vehicles or transport containers for the concrete shall not be permitted to contact any portion of the existing concrete surface prior to placement of the concrete. Protection shall be provided for the concrete surface by means of plywood, mats or other suitable material placed on the surface. Any loose or foreign material or rubber marks accidentally deposited on the surface shall be removed by the contractor prior to low slump concrete placement.

505.10.8.9 Placement of the concrete shall be a continuous operation throughout the pour. Only the minimum amount of concrete necessary for proper placement shall be placed in front of the screeds. If the concrete paver is stopped for any reason, all plastic concrete in front of the paver shall be covered with wet burlap. Concrete shall be poured and finished at a minimum of 2.5 cubic yards per hour for a 12-foot wide pour, except when the contractor elects to pour a wider section, the rate of pour shall be increased proportionately. When concrete is being mixed and placed at the specified minimum rate under normal operations, the finishing machine shall be designed such that the elapsed time between depositing the concrete on the deck and final screeding shall not exceed 10 minutes.

505.10.8.10 If concrete is added to the overlay behind the finishing machine, the area shall be mechanically consolidated again by the finishing machine.

505.10.8.11 After finishing, the contractor shall check the surface with a lightweight 10-foot straightedge. Causes for irregularities exceeding 1/8 inch shall be eliminated and corrections shall be made.

505.10.8.12 The roadway surface finish shall be in accordance with [Sec 703.3.5.5](#). The texture shall not extend into the areas within approximately 12 inches of curbs.

505.10.8.13 After texturing the concrete surface, but before applying the wet cure, all vertical joints with the adjacent concrete shall be sealed by painting with thinned grout consisting of equal parts cement, sand and sufficient water for the mixture to be the consistency of paint.

505.10.8.14 After the joint painting is completed, the freshly placed lane and joint shall be promptly covered with a single layer of clean, wet burlap. Care shall be exercised to ensure that the wet burlap is well drained and that the burlap is placed as soon as the surface will support the burlap without deformation.

505.10.8.15 The wet cure shall be applied within 30 minutes after the concrete has been placed on the deck, except when the surface will be excessively marred by doing so, as determined by the engineer. If the concrete requires refinishing because of failure to meet density requirements, the time will be extended 15 minutes. Failure to apply wet cure within the required time will be cause for rejecting the work affected. Surface concrete in the rejected area shall be removed and replaced by the contractor at the contractor's expense.

505.10.8.16 The surface shall receive a wet cure of at least 72 hours.

505.10.8.17 After placement and cure of the low slump concrete, the finished deck will be tested to detect unbonded areas.

505.10.8.18 As soon as curing has been completed, the riding surface will be thoroughly straightgedged by the engineer and all variations exceeding 1/8 inch in 10 feet will be plainly

marked. Areas more than 1/8 inch high shall be removed by an approved device consisting of multiple cutting edges leaving a grooved surface finish comparable to that produced by the texturing device. A bush hammer or other impact device shall not be used.

505.10.8.19 The surface of low slump concrete shall be sealed in accordance with [Sec 703.3.8](#) and payment for furnishing and placing shall be included in the contract unit price for other items.

505.10.9 Limitations of Operations.

505.10.9.1 Vehicle traffic shall not be permitted on the low slump concrete surface for 72 hours and until 3,000 psi compressive strength is attained.

505.10.9.2 No low slump concrete shall be placed at ambient temperatures below 45 F or above 85 F. Concrete placement may begin when the air temperature and deck temperature is 45 F and rising. Concrete shall not be exposed to freezing temperatures until a strength of 3,000 psi has been attained. Any concrete damaged by freezing shall be removed and replaced at the contractor's expense.

505.10.9.3 When the weather forecast predicts temperatures of 85 F or higher, the contractor shall schedule placing and finishing low slump concrete during hours in which the ambient temperature will be lower than 85 F. The mixed concrete when placed shall have a maximum temperature of 90 F.

505.10.9.4 Concrete shall not be placed adjacent to a parallel surface course that is less than 72 hours old. This restriction will not apply to a continuation of placement in a lane or strip beyond a joint in the same lane or strip.

505.10.9.5 Preparation of the area may be started in a lane or strip adjacent to a newly placed surface the day following placement of the new surface. If this work is started before the end of the 72-hour curing period, the work shall be restricted as follows:

(a) Sawing or other operations shall interfere with the curing process for the minimum practical time only, in the immediate work area only, and the curing shall be resumed promptly.

(b) No power-driven tools heavier than 15 pounds shall be used.

(c) Air compressors shall be operated on the deck only directly over the piers.

(d) No loads other than construction equipment shall be permitted on any portion of the bridge floor that has undergone preparation prior to placement and curing of new concrete.

505.10.10 Removal. All material removed shall be disposed of by the contractor at the contractor's expense in a location meeting the approval of the engineer.

505.10.11 Repair.

505.10.11.1 Unbonded areas will be marked by the engineer. The contractor shall saw cut and remove the affected area. All saw cuts shall be straight vertical lines and form square corners at all changes in direction. After removal of the concrete, the surface of the area to be repaired and vertical saw cuts shall be cleaned of all loose or foreign material by sandblasting and then air blasting. The surface shall be comparable to the original concrete surface prior to the original overlay being placed.

505.10.11.2 The concrete used for repair shall meet the same requirements as the original mixture. The concrete shall be vibrated with a surface or pan-type vibrator to obtain compaction. Spud type vibrators shall not penetrate to contact with the original concrete. Surface finish and curing shall be in accordance with the specifications for the mixture used.

505.10.12 Method of Measurement. Final measurement will not be made except for authorized changes during construction or where appreciable errors are found in the contract quantity. The area of concrete wearing surface will be measured and computed to the nearest square yard. This area will be measured longitudinally from end to end of bridge deck and transversely between roadway face of curbs, excluding from measurement the area of drains and expansion devices. The revision or correction will be computed and added to or deducted from the contract quantity.

505.10.13 Basis of Payment. Payment for the above described work shall be considered completely covered by the contract unit price per square yard of concrete wearing surface.

SECTION 505.20 LATEX MODIFIED CONCRETE.

505.20.1 Description. This work shall consist of constructing a wearing surface of latex modified concrete on a prepared surface in accordance with these specifications as shown on the plans or as directed by the engineer.

505.20.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Type I or II Cement	1019
Latex Emulsion Admixture	1054
Polyethylene Sheeting	1058
Water	1070

505.20.2.1 Aggregate shall be in accordance with [Sec 505.10.2](#).

505.20.2.2 Pozzolanic material or Portland pozzolan cements shall not be used.

505.20.2.3 Latex admixture shall be kept in a suitable enclosure that will protect the admixture from freezing and from exposure to temperatures in excess of 85 F. Drums of latex admixture to be stored at the work site in direct sunlight shall be completely covered with a suitable insulating blanket material to maintain an enclosed temperature below 85 F.

505.20.3 Concrete Mixture.

505.20.3.1 The contractor shall submit a mix design to Construction and Materials meeting the following requirements:

Property	Requirement
Air Content, percent	0 to 6.5
Slump, inches	4 to 6
Percent Fine Aggregate as percent of Total Aggregate by Absolute Volume	50 to 55
Cement Content, lbs./cubic yard min.	658
Latex Emulsion Admixture, gallons/cubic yard. min.	24.5

Net Water/Cement Ratio, max., lbs. ^a water/lbs. cement	0.40
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^a Net water shall be considered the quantity of mixing water added, plus the non-solid portion of the latex emulsion.

505.20.3.2 Any change in mix design or proportions shall be approved by the engineer.

505.20.3.3 Anti-foam additives, as recommended by the latex emulsion manufacturer, may be required if the concrete mixture entrains air above the specified amount.

505.20.3.4 Air-entraining admixtures shall not be added.

505.20.4 Testing. Testing will be done in accordance with [Sec 505.10.4](#), except the slump test will be conducted 4 to 5 minutes after discharge from the mixer. During the waiting period, concrete shall be deposited on the deck and shall not be disturbed.

505.20.5 Mixing.

505.20.5.1 The concrete shall be volumetrically mixed at the bridge site by a continuous mixer in accordance with [Sec 501](#). In addition to other requirements, the mixer shall provide positive control of the latex emulsion into the mixing chamber and the latex emulsion shall calibrate to within ± 2 percent of that required. The mixer shall be capable of continuously circulating the latex emulsion and shall have a flow-through screen between the storage tank and the discharge.

505.20.5.2 The concrete discharged from the mixer shall be uniform in composition and consistency. Mixing capability shall be such that initial and final finishing operations can proceed at a steady pace. Final finishing shall be completed before the formation of a plastic surface film.

505.20.5.3 The moisture content of aggregate at the time of proportioning shall be such that water will not drain or drip from a sample. Coarse and fine aggregate shall be furnished and handled to avoid variations in the moisture content affecting the uniform consistency of the concrete.

505.20.5.4 Each drum of latex admixture shall be mechanically agitated or hand rolled until thoroughly mixed prior to being introduced into the mixer storage compartment. Latex admixture that is stored in the mixer storage compartment overnight or during delays in mixing of four hours or more shall be agitated by at least two complete cycles in a continuous circulating pump or by mechanical means in the storage compartment. The flow through screen shall be cleaned immediately prior to beginning proportioning and as often as necessary thereafter. Latex admixtures of different brands shall not be combined together in any manner.

505.20.6 Surface Preparation. Surface preparation shall be in accordance with [Sec 505.10.6](#) except as specified herein.

505.20.6.1 Prior to scarifying or chipping on concrete adjacent to latex modified concrete, 96 hours of curing shall elapse. If practical, all scarifying by mechanical units shall be completed prior to placing any latex modified concrete, unless otherwise shown on the plans. Areas from which unsound concrete and patches have been removed shall be kept free of slurry produced by wet sawing or wet scarifying by planning the work such that this slurry will drain away from the completed areas of preparation.

505.20.6.2 On both old and new decks, within 24 hours prior to placing latex modified concrete, the entire surface shall be thoroughly cleaned by sandblasting followed by an air blast.

505.20.7 Finishing Equipment.

505.20.7.1 The finishing machine shall be self-propelled and shall be capable of forward and reverse movement under positive control, with a provision for raising all screeds to clear the screeded surface for traveling in reverse. A self-propelled finishing machine with one or more rollers, augers and 1,500 to 2,500 vpm vibratory pans shall be used. A drag float may be necessary. Any modifications will be subject to approval from the engineer.

505.20.7.2 Support rails shall be in accordance with [Sec 505.10.7.4](#).

505.20.8 Placing and Finishing Concrete. Placing and finishing shall be in accordance with [Sec 505.10.8](#) except as specified herein.

505.20.8.1 Prior to placement of latex modified concrete, the cleaned surface shall be thoroughly wetted for a minimum of three hours, then covered with polyethylene sheeting until time of concrete placement. The surface shall be damp at the time the overlay is placed. Any standing water in depressions, holes or areas of concrete removal shall be blown out with compressed air. No free water or puddles of standing water shall exist at the time of placement.

505.20.8.2 Expansion joints and dams shall be formed in the concrete overlay. Formation of the joint by sawing through the overlay will not be permitted.

505.20.8.3 Texturing shall occur immediately after finishing and before the plastic film forms on the surface. Texturing shall be performed in a manner to prevent pulling the concrete away from an existing vertical face. Care shall be taken not to texture too deep and not to tear the surface.

505.20.8.4 Screed rails and headers shall be separated from the newly placed material by passing a pointing trowel along the inside face. Metal expansion dams shall not be separated from the overlayment. The trowel cut shall be made for the entire depth and length of rails or headers after the mixture has stiffened sufficiently and shall prevent the concrete from flowing back into the cut.

505.20.8.5 During placement of the overlay, all joints with adjacent concrete shall be sealed with a mortar paste of equal parts cement and fine aggregate, using latex emulsion in lieu of mixing water.

505.20.8.6 The wet cure shall be applied promptly after the concrete has been placed on the deck without deforming the finished surface.

505.20.8.7 The surface shall receive a wet cure for at least 48 hours.

505.20.8.8 After placement and cure of the latex modified concrete, the finished deck will be tested to detect unbonded areas.

505.20.8.9 No surface sealing shall be applied to the latex modified concrete wearing surface.

505.20.9 Limitations of Operations.

505.20.9.1 No latex modified concrete shall be placed when the ambient or deck surface temperature is above 85 F. Deck temperature shall be determined in accordance with MoDOT Test Method TM 20.

505.20.9.2 No latex modified concrete shall be placed at ambient or deck surface temperatures below 45 F. Latex modified concrete shall be protected to maintain a minimum specified curing temperature of 45 F. Any concrete damaged by freezing or that is exposed to a temperature of less than 45 during the first 8 hours after placement shall be removed and replaced at the contractor's expense.

505.20.9.3 The temperature of the latex modified concrete at time of placement shall be between 45 F and 90 F. If either the aggregate or water is heated, the maximum temperature for each shall be 100 F at the time of addition to the mix. Any method of heating during the mixing of concrete may be used provided the heating apparatus will heat the mass uniformly and avoid hot spots that will burn the material. Cement or aggregate containing lumps or crusts of hardened material or frost shall not be used.

505.20.9.4 No vehicular traffic shall be permitted on the latex modified concrete surface until the concrete is at least 96 hours old and has attained a minimum compressive strength of 3,000 psi.

505.20.9.5 Concrete shall not be placed adjacent to a parallel surface course that is less than 96 hours old; however, this restriction will not apply to a continuation of placement in a lane or strip beyond a joint in the same lane or strip.

505.20.9.6 Preparation of the area, except scarifying, may be started in a lane or strip adjacent to a newly placed surface the day following the surface placement. If this work is started before the end of the 48-hour wet curing period, the work will be restricted such that any interference with the curing process is held to the minimum practical time.

505.20.9.7 Longitudinal construction joints shall be placed between designated traffic lanes. The location of the longitudinal joints will be subject to the approval from the engineer.

505.20.9.8 Transverse joints in the overlay may be permitted if approved by the engineer. These joints shall be located a minimum of 10 feet from the centerline of bent.

505.20.9.9 A header shall be installed in case of delay in the placement operations exceeding one-half hour in duration. During minor delays of one-half hour or less, the end of the placement shall be protected from drying with several layers of wet burlap.

505.20.9.10 Adequate precautions shall be taken to protect freshly placed concrete from rain. All placing operations shall cease when rain begins. The engineer may order removal of any material damaged by rainfall and such material shall be replaced in accordance with these specifications at the contractor's expense.

505.20.10 Removal. Material removal and disposal shall be in accordance with [Sec 505.10.10](#).

505.20.11 Repair. Repair shall be in accordance with [Sec 505.10.11](#).

505.20.12 Method of Measurement. Measurement of latex modified concrete will be in accordance with [Sec 505.10.12](#).

505.20.13 Basis of Payment. Payment for latex modified concrete will be made in accordance with [Sec 505.10.13](#).

SECTION 505.30 SILICA FUME CONCRETE.

505.30.1 Description. This work shall consist of constructing a wearing surface of silica fume concrete on a prepared surface in accordance with these specifications as shown on the plans or as directed by the engineer.

505.30.2 Material. All material shall be in accordance with Division 1000, Material Details, and specifically as follows:

Item	Section
Type I Cement	1019
Air Entraining Admixture	1054
Retarding Admixture	1054
Water-Reducing Admixture	1054
Burlap	1055
Polyethylene Sheeting	1058
Water	1070

505.30.2.1 Silica fume shall be in accordance with [Sec 501](#)

505.30.2.2 Aggregate shall be in accordance with [Sec 505.10.2](#).

505.30.2.3 Pozzolanic material, other than silica fume or Portland pozzolan cements shall not be used.

505.30.2.4 A retarding admixture may be permitted, if recommended by the manufacturer of the silica fume admixture.

505.30.2.5 Approved Type F or G high range water-reducing admixtures will be permitted if specified or recommended by the supplier of the silica fume admixture.

505.30.3 Concrete Mixture.

505.30.3.1 The contractor shall submit a mix design to Construction and Materials with the following properties:

Property	Requirement
Air Content, percent, minimum	5.0
Slump, inches,	3 – 7 1/2
Cement Content, pounds/cubic yard, min	640
Water/Cement Ratio lbs. water/lbs. cementitious materials, max.	0.37
Silica Fume, % replacement of cement	6-8
Percent Fine Aggregate (as percent of total fine and coarse aggregate by absolute volume)	50 – 55
High Range Water Reducer	As required

505.30.3.2 The water content shall include all free moisture in the fine and coarse aggregate, water content of the silica fume admixture and water content of the high range water reducer.

505.30.3.3 The contractor shall designate in the mix design letter what target the slump will be in the field.

505.30.4 Testing. Testing will be done in accordance with [Sec 505.10.4](#).

505.30.5 Mixing.

505.30.5.1 Silica fume concrete shall be batched and mixed in accordance with [Sec 501](#), except as herein specified.

505.30.5.2 High range water-reducing admixtures shall be incorporated and mixed into the silica fume concrete in accordance with the silica fume admixture manufacturer's recommendations and as approved by the engineer. Water-reducing admixtures may be added by hand methods. The water-reducing admixture shall not be mixed with the air-entraining admixture nor shall the water reducer be added to the same portion of the mixing water as the air-entraining admixture. Either the air-entraining admixture or the water-reducing admixture shall be mixed into the concrete before the other is added.

505.30.5.3 Truck mixed silica fume concrete shall be initially mixed for at least 70 revolutions at a rate of no less than 12 revolutions per minute or more than 18 revolutions per minute. Truck mixed silica fume concrete shall be transported to the work site at agitating speeds of 2 to 6 revolutions per minute. After arriving at the work site and before use, the silica fume concrete shall be mixed for at least 30 revolutions at 12 to 18 revolutions per minute.

505.30.5.4 If on-site rotating paddle-type mixers or on-site rotating drum mixers are used, the length of mixing time and the revolution rate shall be as recommended by the silica fume admixture manufacturer.

505.30.5.5 The silica fume admixture manufacturer's technical representative shall advise the engineer in writing of the proper batching sequence, mixing time, mixing speed and other handling procedures necessary to produce a uniform, homogeneous mixture in accordance with this specification prior to preparation of silica fume concrete trial batches or placement of any silica fume concrete.

505.30.5.6 Prior to placement of concrete in the work, the contractor may be required to prepare trial batches of concrete for tests. Trial batches shall comply with and be paid for in accordance with [Sec 501](#).

505.30.6 Surface Preparation. Surface preparation shall be in accordance with [Sec 505.10.6](#).

505.30.7 Finishing Equipment. The finishing machine shall be designed for striking off and finishing silica fume concrete overlay. The finishing machine, screeds, traveling strike off and support rails shall be in accordance with [Sec 505.10.7](#).

505.30.8 Placing and Finishing Concrete. Placing and finishing shall be in accordance with [Sec 505.10.8](#) except as noted herein.

505.30.8.1 The cleaned areas to receive the overlay shall be thoroughly and continuously wetted with water at least three hours before placement of the overlay is started, then covered with polyethylene sheeting until the time of placement. Any accumulations of water shall be dispersed or removed prior to applying the overlay.

505.30.8.2 Since silica fume concrete produces very little bleed water, the engineer may require one or both of the following procedures to maintain a surface film until the burlap is placed.

505.30.8.2.1 A commercially available evaporative retarder may be used judiciously with a misting device during the finishing process until the wet burlap is applied only to prevent the surface of the concrete from drying out. The evaporative retarder shall not be used to increase surface workability.

505.30.8.2.2 Fogging may be done to increase humidity in the area of placement. Any fogging shall be done with nozzles specifically designed for fogging, with a maximum rate of one gallon per minute per nozzle.

505.30.8.3 The surface shall receive a wet cure for at least 7 days. Time when the ambient temperature is below 45 F will not be counted as cure time. Cure shall be continued until 3,000 psi compressive strength has been attained.

505.30.8.4 The finished deck will be examined for cracking. If cracking is found, the engineer will determine whether cracking is detrimental, whether remedial surface repairs are needed or whether the overlay in the cracked area should be removed and replaced. All remedial surface repairs, removal or replacement shall be done by the contractor at the contractor's expense.

505.30.8.5 After placement and cure of the silica fume concrete, the finished deck will be tested to detect unbonded areas.

505.30.8.6 No surface sealing shall be applied to the silica fume concrete wearing surface.

505.30.9 Limitations of Operations. Operations shall be limited in accordance with [Sec 505.10.9](#), except as noted herein.

505.30.9.1 Vehicular traffic shall not be permitted on the silica fume concrete surface for seven days, and in no case until 3,000 psi compressive strength is attained.

505.30.9.2 Silica fume concrete shall not be placed when the air temperature or deck temperature is below 45 F or above 85 F. Concrete placement may begin when the air temperature and deck temperature are 45 F and rising. Concrete shall not be exposed to freezing temperatures until a strength of 3,000 psi has been attained. Any concrete damaged by freezing shall be removed and replaced at the contractor's expense.

505.30.9.3 When the weather forecast predicts temperatures of 85 F or higher, the contractor shall schedule placing and finishing silica fume concrete during hours in which the ambient temperature will be lower than 85 F. The mixed concrete shall not have a temperature higher than 85 F when placed.

505.30.9.4 Since silica fume concrete may not exhibit bleed water, the probability of plastic shrinkage cracking is increased. At surface evaporation rates above 0.1 pound per square foot per hour, plastic shrinkage cracking is probable and the contractor shall take precautions such as erecting windbreaks, lowering the mix temperature or delaying operations until ambient temperatures are lower. Fogging the concrete surface will only be permitted as provided for in this specification. Surface evaporation rates may be predicted from mix temperature, air temperature, relative humidity and wind velocity, using Figure 1 of the 1986 revised edition of ACI 308-81, *Standard Practice for Curing Concrete*.

505.30.10 Removal. Material removal and disposal shall be in accordance with [Sec 505.10.10](#).

505.30.11 Repair. Repairs shall be in accordance with [Sec 505.10.11](#).

505.30.12 Method of Measurement. Measurement of silica fume concrete will be in accordance with [Sec 505.10.12](#).

505.30.13 Basis of Payment. Payment for silica fume concrete will be made in accordance with [Sec 505.10.13](#).

SECTION 505.40 LATEX MODIFIED HIGH EARLY STRENGTH CONCRETE.

505.40.1 Description. This work shall consist of a wearing surface of latex modified high early strength concrete constructed on a prepared surface in accordance with this specification and in accordance with lines, grades, thickness and typical cross sections shown on the plans or as directed by the engineer.

505.40.2 Material. All material shall be in accordance with [Sec 505.10](#), Division 1000, Materials Details and specifically as follows:

Item	Section
Latex Emulsion Admixture	1054
Polyethylene Sheeting	1058
Water	1070

505.40.2.1 With approval of the engineer, a Type HE high-early-strength cement, in accordance with ASTM C 1157, may be used. Type III cement will not be permitted.

505.40.2.2 Coarse aggregate shall be an approved crushed limestone, crushed quartzite, flint chat from the Joplin area, or porphyry in accordance with [Sec 1005](#), Gradation E or Gradation F, except the percentage of deleterious substances shall not exceed the following values, and the sum of percentages of all deleterious substances shall not exceed one percent.

Item	Percent by Weight (Mass)
Deleterious Rock	1.0
Shale and Pyrite	0.2
Chert in Limestone	0.5
Other Foreign Material	0.1

505.40.2.3 Fine aggregate shall be in accordance with [Sec 1005](#) and shall be Class A sand in accordance with [Sec 501](#).

505.40.2.4 With approval of the engineer, other gradations of coarse or fine aggregate may be used, however all quality requirements, including a maximum of 2.0 percent passing the No. 200 for fine and coarse aggregate, shall apply and the maximum aggregate size shall not exceed that of [Sec 1005](#), Grade E aggregate.

505.40.2.5 Pozzoloanic material or Portland pozzolan cements shall not be used.

505.40.2.6 Latex admixture shall be kept in suitable enclosures which will protect it from freezing and from exposure to temperatures in excess of 85 F.

505.40.3 Concrete Mixture.

505.40.3.1 The concrete mixture shall meet the following requirements:

Property	Specific Value
Air Content percent	0 to 6.5
Slump, inches	3 to 6
Percent Fine Aggregate as percent of total aggregate by weight	50 to 55
Cement Content, lb/cu yd min.	658
Latex Emulsion Admixture, gal/cu yd	24.5
Net Water-Cement Ratio, max. Lbs. ^a of water/lbs. of cement	0.40

^aNet water shall be considered the quantity of mixing water added plus the non-solid portion of the latex emulsion.

505.40.3.2 Chloride permeability shall not be greater than 1000 coulombs when tested in accordance with AASHTO T 277. Tests shall be performed on specimens at 28-days. This test shall be performed on each mixture submitted for approval. The tests are to be performed by a qualified commercial laboratory.

505.40.3.3 The mixture shall be designed to develop a minimum 28-day compressive strength of 4,500 psi.

505.40.3.4 Anti-foam additives as recommended by the latex emulsion manufacturer may be required if the concrete mixture entrained air is above the specified amount.

505.40.3.5 Air-entraining admixtures shall not be added.

505.40.3.6 A set control in accordance with the cement manufacturer's recommendation may be considered.

505.40.3.7 Admixtures containing calcium chloride shall not be used.

505.40.4 Mix Design. The contractor shall submit the mix design to Construction and Materials for approval. The mix design shall be within the limits specified in this provision. The mix design shall also include actual test results for the following information:

- (a) Air.
- (b) Slump.
- (c) Compressive strengths at 4-hours, 8-hours, 12-hours, 24-hours, 7-days and 28-days. Compressive strengths determined using 6 x 12 inch cylinders.
- (d) Results of chloride permeability testing.

505.40.4.1 If other aggregate gradations than standard specifications are utilized, the contractor shall designate the intended target gradation and allowable gradation range for each fraction. The target gradations and allowable gradation ranges will be used for inspection and quality control of the aggregates.

505.40.4.2 Any change in mix design or proportions shall be approved by the engineer.

505.40.5 Testing. Testing will be done in accordance with [Sec 505.10](#), except that the slump test will be conducted 4 to 5 minutes after discharge from the mixer. During the waiting period, concrete shall be deposited on the deck and shall not be disturbed.

505.40.6 Mixing.

505.40.6.1 The concrete shall be volumetrically mixed at the bridge site by a continuous mixer in accordance with [Sec 501](#). In addition to other requirements, the mixer shall provide positive control of the latex emulsion into the mixing chamber, and the latex emulsion shall calibrate to within ± 2 percent of that required. The mixer shall be capable of continuously circulating the latex emulsion and have a flow-through screen between the storage tank and the discharge.

505.40.6.2 The concrete discharged from the mixer shall be uniform in composition and consistency. Mixing capability shall be such that initial and final finishing operations can proceed at a steady pace. Final finishing shall be completed before the formation of a plastic surface film on the surface.

505.40.6.3 The moisture content of aggregates at the time of proportioning shall be such that water will not drain or drip from a sample. Coarse and fine aggregate shall be furnished and handled to avoid variations in the moisture content affecting the uniform consistency of the concrete.

505.40.6.4 Each drum of latex admixture shall be mechanically agitated or hand rolled until thoroughly mixed prior to being introduced into the mixer storage compartment. Latex admixture that is stored in the mixer storage compartment overnight or during delays in mixing of four hours or more shall be agitated by at least two complete cycles in a continuous circulating pump or by mechanical means in the storage compartment. The flow through screen shall be cleaned immediately prior to beginning proportioning and as often as necessary thereafter. Latex admixtures of different brands shall not be combined together in any manner.

505.40.6.5 The water/cement ratio shall be within 0.02 of that specified in the approved mix design. If adjustments for water content beyond that are necessary, a previously tested and approved mixture shall be used.

505.40.6.6 Prior to placement of concrete in the work, the contractor shall be required to prepare trial batches of concrete for testing. Trial batches shall comply with the limits specified in this provision.

505.40.7 Surface Preparation. Surface preparation shall be in accordance with [Sec 505.10](#) except as specified herein.

505.40.7.1 Prior to scarifying or chipping on concrete adjacent to latex modified high early strength concrete, 24 hours of curing shall elapse. If practical, or unless otherwise shown on the plans, all scarifying by mechanical units shall be completed prior to placing any latex modified high early strength concrete. Areas from which unsound concrete and patches have been removed shall be kept free of slurry produced by wet sawing or wet scarifying by planning the work such that this slurry will drain away from the completed areas of preparation.

505.40.7.2 On both old and new decks within 24 hours before latex modified high early strength concrete placement begins, the entire surface shall be thoroughly cleaned by hydro blasting followed by an air blast in accordance with [Sec 505.10](#).

505.40.8.0 Finishing Equipment.

505.40.8.1 The finishing machine shall be self-propelled with one or more rollers, augers and vibratory pans capable of 1,500 to 2,500 vpm. It shall also be capable of forward and reverse

movement under positive control, with a provision for raising all screeds to clear the screeded surface for traveling in reverse. A drag float may be necessary. Any modifications shall be subject to approval from the engineer.

505.40.8.2 Support rails shall be in accordance with [Sec 505.10](#).

505.40.9 Placing and Finishing Concrete. Placing and finishing shall be in accordance with [Sec 505.10](#) except as specified herein.

505.40.9.1 Prior to placement of latex modified high early strength concrete, the cleaned surface shall be thoroughly wetted for a minimum of one hour, then covered with polyethylene sheeting until time of concrete placement. The surface shall be damp at the time the overlay is placed. Any standing water in depressions, holes or areas of concrete removal shall be blown out with compressed air. No free water or puddles of standing water shall exist at the time of placement.

505.40.9.2 Expansion joints and dams shall be formed in the concrete overlay. Formation of the joint by sawing through the overlay will not be allowed.

505.40.9.3 Water shall not be added to the surface of the concrete during finishing. A commercially available evaporation retardant may be used judiciously with a misting device during the finishing process until the wet burlap is applied only to prevent the surface of the concrete from drying out. The evaporation retardant shall not be used to increase surface workability.

505.40.9.4 Texturing shall occur immediately after finishing and before the plastic film forms on the surface. Texturing shall be performed in a manner to prevent pulling the concrete away from an existing vertical face. Care shall be taken not to texture too deep and not to tear the surface.

505.40.9.5 Screed rails and headers shall be separated from the newly placed material by passing a pointing trowel along their inside face. Metal expansion dams shall not be separated from the new overlay. The trowel cut shall be made for the entire depth and length of rails or headers after the mixture has stiffened sufficiently and shall prevent the concrete from flowing back into the cut.

505.40.9.6 During placement of the overlay, all joints with adjacent concrete shall be sealed with a mortar paste of equal parts cement and fine aggregate, using latex emulsion in lieu of mixing water.

505.40.9.7 The overlay concrete shall be moist cured from the time placed until opened to traffic.

505.40.9.8 The wet cure shall be applied promptly after the concrete has been placed on the deck without deforming the finished surface.

505.40.9.9 Within one hour of covering with wet burlap, a layer of white polyethylene sheeting shall be placed on the wet burlap. The surface shall receive a wet cure until the latex modified high early strength concrete has attained a compressive strength of at least 3,200 psi.

505.40.9.10 The thickness of the overlay shall not exceed 3 inches, unless otherwise approved by the engineer.

505.40.9.11 The finished deck will be examined for cracking. If cracking is found, the engineer will determine whether cracking is detrimental, whether remedial surface repairs are

needed or whether the overlay in the cracked area should be removed and replaced. All remedial surface repairs, removal or replacement shall be done by the contractor at the contractor's expense.

505.40.9.12 After placement and curing of the latex modified high early strength concrete, the finished deck will be tested to detect unbonded areas.

505.40.9.13 No surface sealing shall be applied to the latex modified high early strength concrete wearing surface.

505.40.10 Limitations of Operations.

505.40.10.1 No latex modified high early strength concrete shall be placed when the ambient or deck surface temperature is above 85 F. Deck temperature shall be determined in accordance with MoDOT Test Method T20.

505.40.10.2 Since latex modified high early strength concrete may not exhibit bleed water, the probability of plastic shrinkage cracking is increased. At surface evaporation rates above 0.1 pounds per square foot per hour plastic shrinkage cracking is probable and the contractor should take precautions such as erecting windbreaks, lowering the mix temperature or delaying operations until ambient temperatures are lower. Fogging the concrete surface will only be allowed, as provided for in this specification. Surface evaporation rates can be predicted from mix temperature, air temperature, relative humidity and wind velocity using Figure 1 of ACI 308-81 (revised 1986) "Standard Practice for Curing Concrete".

505.40.10.3 A fogging system shall be in-place prior to concrete placement. The fogging system shall consist of pressurized equipment that distributes water at minimum rate of 0.10 gallon per hour per square foot. The fogging system shall apply the fog uniformly over the entire surface of the bridge deck. The fogging system shall produce atomized water that has a droplet with a maximum diameter of 0.003 inches and which keeps the finished deck surface saturated without producing standing water. The contractor shall submit a letter certifying that their fogging system is in accordance with this provision.

505.40.10.4 The fogging system shall be started progressively along the length of the deck, during or immediately after floating.

505.40.10.5 No latex modified high early strength concrete shall be placed at ambient or deck surface temperatures below 45 F. Latex modified high early strength concrete shall be protected to maintain a minimum specified curing temperature of 45 F. The contractor shall provide a method, meeting the approval of the engineer, of monitoring the concrete that demonstrates that the concrete has been maintained above the minimum curing temperature and has been protected from freezing. Any concrete damaged by freezing or which is exposed to a temperature of less than 45 F during the first 8 hours after placement shall be removed and replaced at the contractor's expense.

505.40.10.6 The temperature of the latex modified high early strength concrete at time of placement shall be between 45 F and 90 F. If either the aggregate or water is heated, the maximum temperature for each shall be 100 F at the time of addition to the mix. Any method of heating during the mixing of concrete may be used provided the heating apparatus will heat the mass uniformly and avoid hot spots which will burn the material. Cement or aggregate containing lumps or crusts of hardened material or frost shall not be used.

505.40.10.7 No vehicle traffic shall be permitted on the latex modified high early strength concrete surface until the latex modified high early strength concrete has attained a minimum

compressive strength of 3,200 psi. Compressive strength will be determined by tests conducted in accordance with MoDOT test methods.

505.40.10.8 Concrete shall not be placed adjacent to a parallel surface course which is less than 24 hours old; however, this restriction will not apply to a continuation of placement in a lane or strip beyond a joint in the same lane or strip.

505.40.10.9 Preparation of the area, except scarifying, may be started in a lane or strip adjacent to newly placed surface the day following the surface placement. If this work is started before the end of the curing period, the work will be restricted such that any interference with the curing process is held to the minimum practical time only.

505.40.10.10 Longitudinal construction joints shall be placed between designated traffic lanes. The location of the longitudinal joints shall be subject to the approval from the engineer.

505.40.10.11 Transverse joints in the overlay may be permitted if approval by the engineer. Transverse joints shall be located a minimum of 10 feet from the centerline of bent.

505.40.10.12 A header shall be installed in case of delay in the placement operations exceeding one-half hour in duration. During minor delays of one-half hour or less, the end of the placement shall be protected from drying with several layers of wet burlap.

505.40.10.13 Adequate precautions shall be taken to protect freshly placed concrete from rain. All placing operations shall stop when rain begins. The engineer may order removal of any material damaged by rainfall and such material shall be replaced in accordance with this specification at the contractor's expense.

505.40.11 Removal. Material removal and disposal shall be in accordance with [Sec 505.10](#).

505.40.12 Repair. Repair shall be in accordance with [Sec 505.10](#).

505.40.13 Method of Measurement. Measurement will be in accordance with [Sec 505.10](#).

505.40.14 Basis of Payment. The basis for payment will be in accordance with [Sec 505.10](#).