#27 COMPLETE

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Q1: State Representative

Name	Shannon Golden
Agency	Alabama Department of Transportation
State / Province	Alabama
Email	goldens@dot.state.al.us

Q2: Do you a high performance bridge deck mix specification?

No

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
MAXIMUM PERCENT MINERAL ADMIXTURE SUBSTITUTION FOR PORTLAND CEMENT (substitution by weight) MINERAL ADMIXTURE PERCENTAGE SUBSTITUTION Class C or Class F Fly Ash 30 % Ground Granulated Blast Furnace Slag 50 % Microsilica 10 %

Q4: Have you used fibers in bridge deck mixes?

No

Q5: Have you used shrinkage reducing admixtures in bridge decks?

No

Q6: Have you used lightweight aggregate in bridge deck mixes?

No

Q7: What are your curing requirements for bridge decks?

BRIDGE DECK SLABS.

a. General.

Prior to placing a bridge deck slab, the evaporation rate shall be determined by use of the graph in Figure 1, "Evaporation Rate of Surface Moisture", and recorded on form BMT-171, "Evaporation Rate Record". The Contractor shall furnish the equipment necessary to measure the air temperature (ambient), wind velocity, and humidity. The equipment or a manufacturer's certificate of calibration showing the equipment's model number and serial number shall be submitted to the Division Materials Engineer no less than 14 days prior to their use. The equipment shall consist of the following instruments with the following specifications.

1. Anemometer: Range – 0-25mph {0-40 km/hr}. Accuracy – plus or minus 1.5%.
   Units – U.S. Customary and Metric.
2. Hygrometer: Range – 10-95% relative humidity.
   Accuracy – plus or minus 1.5%.
   Units - U.S. Customary and Metric.
   Certified and traceable to N.I.S.T.
3. Thermometer: range – 0-140 ≈F {0-60 ≈C}.

3. Thermometer: Range – 0-140 ≠F {0-60 ≠C}.
Accuracy – plus or minus 2 ≠F {plus or minus 1 ≠C}
Units - U.S. Customary and Metric.

Combination instruments such as anemometer and thermometer or hygrometer and thermometer will be accepted provided they meet the above requirements.

If the placement is expected to last more than two hours, the evaporation rate shall be checked and recorded on form BMT-171 at two-hour intervals or less. To prevent plastic shrinkage cracking, the expected evaporation rate shall not exceed 0.2 pounds per square foot per hour {1.0 kg/m2/hour}. When the evaporation rate exceeds this amount, the Contractor shall be required to effectively reduce the rate to within the allowable limits by taking one or more of the following actions:

(1) Construct windbreaks or enclosures to effectively reduce the wind velocity throughout the area of placement.

(2) Use fog sprayers or sprinklers upwind of the placement operation to effectively increase the relative humidity.

(3) Reduce the temperature of the concrete.

The Department will evaluate plastic shrinkage cracks that occur. Remedial measures shall be performed as directed by the Engineer. Plastic shrinkage cracks shall never be troweled over or filled with slurry.

FIGURE 1. Evaporation Rate of Surface Moisture

b. Evaporation Control After Screeding.

Continuous fogging or an evaporation barrier (monomolecular) material shall be used for all bridge deck curing beginning immediately after the screeding operations have been completed for sections of the deck not to exceed five feet from the starting location.

If fogging is to be used, a continuous fog or mist spray shall be maintained until the moist curing procedures described elsewhere in this Section begin. Intermittent fogging is not acceptable if there is drying of the concrete surface. If water begins to pond on the deck, the Contractor shall adjust the rate of fogging to minimize the ponding of water.

If an evaporation barrier material is to be used, it shall be applied immediately behind the screeding operation and in accordance with the manufacturer's recommendations. The entire top portion of the concrete slab shall be covered with the barrier material applied under pressure at a rate of one gallon {liter} to not more than 200 square feet {5 m2} of fresh concrete. Application shall be done with an industrial type sprayer in such a manner as to cover the surface being treated with a uniform film.

c. Moist Curing After Finishing.

Immediately after the finishing operation, concrete bridge decks shall be moist cured for seven days by maintaining a moist condition for the entire curing period. This may be accomplished by one of the following methods:

(1) Fog spraying or sprinkling with nozzles or sprinklers. When using this method, the Contractor shall maintain a complete and continuous moist condition of the concrete surface. Intermittent sprinkling is not acceptable. Care shall be taken that erosion of the surface does not occur.

(2) Saturated burlap, saturated plastic coated burlap, or cotton mats. These curing materials shall be clean and free from any injurious substances that can cause deleterious effects to the concrete or cause discoloration. The burlap or cotton shall be completely saturated before being placed on the concrete and shall be maintained in that condition for the entire curing period. Should tears or holes appear in the mat sheets, they shall be repaired immediately. All edges of burlaps and mats shall extend at least 18 inches {450 mm} beyond the concrete surface. Where two individual sheets join, their edges shall overlap at least 12 inches {300 mm}. All edges and overlaps shall be secured to ensure that the concrete surface is completely covered during the entire curing period. These curing materials shall be kept in contact with the concrete surface at all times. Alternate cycles of wetting and drying shall be avoided because this may result in pattern cracking.

Prior to the start of the curing operation, the contractor shall have an approved curing system that ensures continuous moist curing of the concrete for 24 hours per day.

If water or the chosen curing material stains or discolors concrete surfaces, which are permanently exposed, the contractor shall be responsible for cleaning the surfaces. When wooden forms are left in place during curing, they shall be kept wet at all times. If steel forms are used in hot weather, non-supporting vertical forms shall be broken loose from the concrete and curing water continually applied in this void. If the forms are removed before the end of the curing period, curing shall be carried out as on unformed surfaces.

3. PROTECTION OF CONCRETE DURING CURING.

Green concrete shall be protected against jarring or other movement that might cause damage. No traffic or other superimposed load will be permitted over bridges or culverts until the following criteria have been met:

(1) Bridges The deck concrete shall have reached a minimum 4000 psi {28 MPa} compressive strength as determined from test cylinders.

Q8: Do you have smoothness requirements for bridge decks?	If yes, what criteria do you use and how is it measured. As soon as the surface has set sufficiently, it shall be straight-edged by the Contractor under the direction of the Engineer and all areas exceeding 1/8 inch in 10 feet from the longitudinal and transverse lines shown on the plans shall be marked and corrected by approved methods. The 10 foot straight-edge shall be lapped at least 5 feet over the prior 10 foot check.
Q9: Do you typically grind bridge decks?	No
Q10: Do you seal bridge decks?	No

Q11: What type of sealers do you allow/specify?

Silane	Do not use
Siloxane	Do not use
Methylmethacrylate	Do not use
Epoxy Chip Seal	Do not use
Polymer Modified Overlay	Do not use
Other	Do not use

Q12: What is the application rate for each sealer?

Silane	Do not use
Siloxane	Do not use
Methylmethacrylate	Do not use
Epoxy Chip Seal	Do not use
Polymer Modified Overlay	Do not use
Other	Do not use

Q13: What is the typical performance life of a sealed joint?

8 years

Q14: If you seal bridge decks, how often do you retreat? No

Q15: Please attach a link to approved products list and approval process for joint sealants.

http://www.dot.state.al.us/mtweb/Testing/MSDSAR/doc/QMSD/Liii04.pdf

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.	If Yes, what is it? ALABAMA DEPARTMENT OF TRANSPORTATION DATE: January 18, 2013 Special Provision No. 12-0768 SUBJECT: Shotcrete Alabama Standard Specifications, 2012 Edition, shall be amended by the addition of a new SECTION 571 as follows: SECTION 571 SHOTCRETE 571.01 Description. This work shall consist of furnishing and placing one or more courses of shotcrete and reinforcing steel on a prepared surface. The shotcrete shall be a concrete mixture that is pneumatically projected at high velocity onto the

surface. 571.02 Materials. (a) GENERAL. Materials shall conform to the requirements given in Division 800, Materials. Specific reference is made to applicable portions of the following Sections: Section 801 Coarse Aggregate Section 802 Fine Aggregates Section 806 Mineral Admixtures Section 807 Water Section 808 Air Entraining Admixtures Section 809 Chemical Admixtures for Concrete Section 815 Cement Section 835 Steel Reinforcement Section 852 Underdrain Pipe Materials (b) AGGREGATES. When coarse aggregates are used, the coarse and fine aggregate shall be weighed separately to avoid segregation. Oversize pieces of aggregate shall be removed by screening. The combined aggregates shall meet one of the following gradations: GRADATIONS FOR COMBINED AGGREGATES FOR SHOTCRETE SIEVE SIZE PERCENT BY WEIGHT PASSING INDIVIDUAL SEIVES GRADATION No. 1 GRADATION No. 2 3/4 inch -- -- 1/2 inch -- 100 3/8 inch 100 90 – 100 No. 4 95 – 100 70 – 85 No. 8 80 – 100 50 – 70 No. 16 50 – 85 35 – 55 No. 30 25 – 60 20 -35 No. 50 10 – 30 8 – 20 No. 100 2 – 10 2 – 10 (c) SHOTCRETE MIX DESIGN. The Contractor shall design the shotcrete mix and shall verify the performance of the design of the mix by trial mixes and laboratory tests. The Contractor shall submit the proposed mix design and test results to the Materials and Tests Engineer. The placement of the shotcrete shall not begin until the mix design is approved through field placement tests and compressive strength testing described in Article 571.03. Type I or Type III cement shall be used. The type and dosage of mineral and chemical admixture, if proposed for use, shall be included in the mix design, verification mixes, and production mix. The design, verification, and production of shotcrete mixes shall result in the shotcrete having the following properties: PHYSICAL PROPERTIES OF SHOTCRETE TYPE OF SHOTCRETE PLACEMENT PROCESS MINIMUM CEMENTITOUS MATERIAL CONTENT (POUNDS PER CUBIC YARD MAXIMUM WATER-CEMENTITOUS MATERIAL RATIO (W/C) (1) AIR CONTENT RANGE, EA(2) (%) MINIMUM COMPRESSIVE STRENGTH AT 28 DAYS(3) (psi) Wet 550 0.55 NA 4000 Dry 550 0.50 NA 4000 Wet (w/TAC(2)) 550 0.45 2.5 to 6.0 4000 Notes: (1) W/C = Water-Cementitious Ratio (by weight). (2) TAC = Total Air Content (3) As per AASHTO T 23 (d) MINERAL ADMIXTURES. Fly ash may be used as part of the cementitious material in the shotcrete mix. Class “F” or Class “C” fly ashes may be substituted for cement up to a maximum substitution rate of 20 % of the total weight of the cementitious materials. Ground Granulated Blast Furnace Slag (GGBFS) may be used as part of the cementitious material in the shotcrete mix. GGBFS may be substituted for cement up to a maximum substitution rate of 30 % of the total weight of the cementitious materials. Microsilica may be used as part of the cementitious material in the shotcrete mix. Microsilica may be added up to a maximum addition rate of 10 % of the total weight of the

cementitious materials. (e) CHEMICAL ADMIXTURES. Air entraining admixtures and water reducing admixtures may be used for wet-mix shotcrete only. Type "F" admixtures may be used for wet-mix shotcrete only to promote workability without exceeding the maximum allowable water-cementitious ratio. Admixture addition rates, dispensing, and mixing of the admixture shall be in accordance with the admixture manufacturer's recommendations. 571.03 Construction. (a) ANCHORAGE AND REINFORCEMENT. The details of the anchorage and reinforcement of the shotcrete will either be shown on the plans or will be given elsewhere in the specifications when the shotcrete is required as a part of other items of work. (b) BATCHING, MIXING AND PLACING SHOTCRETE. The requirements for batching, mixing and placing shotcrete shall be as described in ACI 506R, "Guide to Shotcrete". Metal wires shall be used to control the thickness and surface of the shotcrete. The temperature of the shotcrete mix shall be maintained between 50 ° F and 90 ° F. (c) EQUIPMENT. 1. SUBMITTAL OF DESCRIPTION OF EQUIPMENT. The Contractor shall submit a written description of the proposed equipment for mixing and applying shotcrete. The submittal shall include the equipment manufacturer's instructions, recommendations, literature, performance, and test data. This submittal shall be delivered to the Engineer. The placement testing of the shotcrete shall not begin until the Engineer informs the Contractor that the submittal is complete and the proposed mix design (or designs) have been evaluated for completeness by the Materials and Tests Engineer. The Contractor may use the information given in ACI 506R for identifying the equipment required for mixing and applying shotcrete. 2. WATER SUPPLY SYSTEM FOR THE DRY MIX PROCESS. For the dry-mix process the Contractor shall provide a water storage tank at the job site. The Contractor shall also provide a positive displacement pump with a regulating valve that is accurately controlled to provide water at the required pressure and volume. 3. MIXING AND PLACING EQUIPMENT. The Contractor shall use equipment capable of handling and applying shotcrete containing the proposed maximum size aggregate and admixtures. 4. AIR HOSE AND BLOWPIPE. An air hose and blow pipe shall be provided by the Contractor to clear dust and rebound during shotcrete application. 5. AIR SUPPLY SYSTEM. An air supply system shall be provided by the Contractor. The air supply system shall be capable of supplying the delivery machine and hose with air at the pressures and volumes recommended by the machine manufacturer. Air supply systems that deliver oil-contaminated air, or are incapable of maintaining constant pressure shall not be used. (d) TESTING OF MATERIALS AND PLACEMENT PROCESS PRIOR TO CONSTRUCTION. 1. REQUIREMENT FOR FIELD TESTING. The Contractor shall perform a field test at least 30 calendar days before starting shotcrete production. The proposed mix design (or designs) shall be tested using the same equipment and

shall be tested using the same equipment and personnel that will be used in production. The Contractor shall make arrangements for the Engineer to be present at the placement of the shotcrete for testing and at all of the subsequent testing of the samples of the shotcrete. 2. TEST PANELS FROM FIELD TESTS. Application of shotcrete on test panels shall be done in the same manner that will be used for the production placement of the shotcrete. Test panels shall be fabricated in accordance with the requirements given in ASTM C 1140, "Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panel", as may be modified by the requirements given in this Section. The proposed mix shall be tested on two panels at least 3 feet by 3 feet in size. The thickness of the test panels shall be the same thickness as is required for the production placement. One panel shall be reinforced exactly like the production shotcrete will be reinforced. Test panels shall be cured in the same manner that the production shotcrete will be cured. 3. CORING TEST PANELS. Six cores shall be obtained from each test panel for testing. Each core shall be 3 inches in diameter and the full thickness of the test panel. The cores shall be taken from each test panel in accordance with the requirements given in AASHTO T 24. Cores shall be extracted no more than 2 hours before testing. 4. TESTING OF CORES FROM TEST PANELS. Three cores from the unreinforced panel shall be tested for compressive strength at an age of 7 days. Three cores from the unreinforced panel shall be tested for compressive strength at an age of 28 days. Compressive strength tests shall be performed in accordance with the requirements given in AASHTO T 24, "Obtaining and Testing Drilled Cores and Sawed Beams of Concrete". Six cores shall be extracted from the reinforced panel at an age of 7 days for visual evaluation and nozzle operator qualification. These cores shall be delivered to the Materials and Tests Engineer for evaluation. The cores will be graded according to the requirements given in ACI 506.2, "Specification for Shotcrete". (e) SUBMITTAL OF MATERIAL TEST DATA AND PROPOSED PLACEMENT PROCESS. The Materials and Tests Engineer will approve or reject the proposed mix design and placement process based on the results of the field testing and laboratory tests. Any changes to a previously accepted mix or the proposal of a new mix design will require field testing and laboratory testing before approval. The Contractor shall submit three copies of the test data and proposed placement process data to the Engineer for evaluation by the Materials and Tests Engineer. This data shall be submitted within 4 calendar days after the completion of the compressive strength tests that are performed on the cores at 28 days of age. The following data shall be submitted: - Sample identification including mix design and test panels represented. - Date and time of sample preparation including curing conditions. - Date and time of testing. - Sample dimensions. - Complete test results including load, sketches or pictures of samples before and after testing, and any

pictures of samples before and after testing, and any unusual occurrences observed. - Name of laboratory and technician performing the tests. - Nozzle operator's experience and training. If more than one nozzle operator is used, each operator shall perform a set of test panels for each mix design proposed. Only nozzlemen with a test panel mean core grade less than or equal to 2.5 (as determined from the requirements given in ACI 506.2) will be allowed to place shotcrete. The Engineer will inform the Contractor of the approval of the mix design and proposed placement equipment and procedures after an evaluation of the submittal that is made to the Materials and Tests Engineer. (f) WEATHER. The placement of the shotcrete shall be stopped if: - the wind is detrimental to the placement of the shotcrete; - when the air temperature is below 40 ºF or above 90 ºF; -raining or lightning. (g) TIME LIMIT FOR PLACING SHOTCRETE. The placement of dry-mix shotcrete shall begin within 45 minutes of the beginning of the mix production. A new batch of shotcrete shall be produced if placement does not begin within 45 minutes or if placement is not continuous. The placement of wet-mix shotcrete shall begin within 60 minutes after batching. A new batch of shotcrete shall be produced if placement does not begin within 45 minutes or if placement is not continuous. (h) THICKNESS OF LAYERS AND TIME BETWEEN PLACEMENTS OF LAYERS. Shotcrete shall be placed in one continuous lift thickness up to a maximum lift thickness of 6 inches. For shotcrete layer thicknesses greater than 6 inches, shotcrete shall be placed in lift thicknesses equal to one half the required thickness but no more than 6 inches per lift. If more than one lift is required there shall be a delay of time between the placement of each lift. The delay shall be until the initial set of the shotcrete. The initial set shall be defined as the point in time when the shotcrete has reached a compressive strength of 500 psi. The determination of initial set will be done by the Engineer using a penetrometer in accordance with the requirements given in AASHTO T 197, "Time of Setting of Concrete Mixtures by Penetration Resistance". The Contractor shall furnish a penetrometer that is determined by the Engineer to be adequate for measuring the compressive strength. The Engineer shall have exclusive possession and use of the penetrometer beginning at least 5 calendar days before the start of shotcrete placement. The penetrometer will be returned to the Contractor when shotcrete placement is completed. At the point in time when the initial set is achieved, the surface shall be lightly broomed to remove laitance to provide an adequate bond with the next application of shotcrete. The Engineer will also determine when the shotcrete has taken a final set and remedial actions shall be taken by the Contractor to insure a bonding of subsequent layers of shotcrete. (i) CONSTRUCTION JOINTS. Boards or other solid materials shall be installed to provide the construction joints. The solid joint materials shall be removed and the joints shall be thoroughly cleaned before additional shotcrete is placed at the joint. (j) CURING. Two methods will be

placed at the joint. (j) CURING. Two methods will be allowed for curing. The first method of curing is by keeping the surface of the shotcrete continually moist for at least 7 days by burlap that is kept wet. The second method of curing is by using an impervious membrane (curing compound) meeting the requirements given in Section 830. (k) SURFACE FINISH. 1. RETAINING WALLS. The final surface of the shotcrete shall be finished to an even plane. The surface shall be finished to within 1/2 inch in 10 feet as measured by placing a straightedge anywhere on the surface of the shotcrete. All metal construction materials such as guide wires and tie wires that protrude through the surface shall be removed from the surface by breaking back the protrusion and patching the flaw with cement mortar as directed by the Engineer. The shotcrete wall shall be finished with a slight chamfer at the exterior edges of the wall. Any additional surface finishing requirements will be shown on the plans. 2. ROCK FACE PROTECTION. The shotcrete surface shall be left in the natural shotcrete gun finish. (l) DRAINAGE If draining of water from behind the shotcrete is required the details of the drainage system will be shown on the plans. (m) CLEANING EXCESSIVE SHOTCRETE. The excessive placement of shotcrete shall be continuously removed to protect the adjacent areas and keep the prior placement of shotcrete clean. "Rebound" shotcrete shall be promptly removed from the work area. (n) DEFECTIVE WORK. Areas of defective work shall be replaced. The Contractor shall submit a written replacement procedure to the Engineer for review prior to making the repair. All repair work shall be performed without additional compensation. (o) SHOTCRETE PRODUCTION REPORT. The Contractor shall submit a written report of the shotcrete production and application to the Engineer within 24 hours of the completion of shotcrete application. The following shall be included in the report: - quantity and location of shotcrete applied including sketches of areas where shotcrete was placed; - observations of success or problems of equipment operation, application, final condition, and any other relevant issues encountered during production and application; - the batch number of the shotcrete; - name of nozzleman; - name and signature of the Contractor's supervisor performing the observation. (p) TEST PANELS, CORING AND TESTING DURING PRODUCTION PLACEMENT. The Contractor shall produce a test panel in accordance with the requirements given in ASTM C 1140 for each work day or every 50 cubic yards of shotcrete placed, whichever is less. Test panels shall be kept moist at all times. The panels shall be kept between 60 ° F to 80 ° F for the first 24 to 48 hours before they are moved to the testing laboratory for standard curing. Five cores for compressive strength test specimens shall be obtained from each panel and shall be tested in accordance with the requirements given in AASHTO T 24. Two samples shall be tested at 7 days and three at 28 days. Test reports shall be forwarded to the Engineer within 24 hours after

forwarded to the Engineer within 24 hours after testing. Cores for testing shall be obtained from the panels no more than 2 hours before testing. It shall be the responsibility of the Contractor to retain a testing laboratory, approved by the Department, to perform these tests. 571.04 Method of Measurement. Shotcrete may be measured as a part of other items of work. A separate quantity of shotcrete will not be given when it is included in other items of work. When direct payment is made for shotcrete it will be measured in units of square yards at the surface of the shotcrete placement. The square yardage will be limited to the actual number of square yards placed within lines shown on the plans, or designated by the Engineer, that define the plan limits of the required shotcrete placement. All portions of shotcrete placed outside the limits of measurement will be considered incidental to the placement of the shotcrete. 571.05 Basis of Payment. (a) UNIT PRICE COVERAGE. The contract unit price for shotcrete shall be full compensation for all materials, equipment tools, labor, testing and incidentals required to complete this item of work. The contract unit price includes preparation of the surface to be treated, furnishing and installation of wire reinforcement and anchor bolts and the furnishing and installing the materials required for drainage and final surface finishing. (b) PAYMENT WILL BE MADE UNDER ITEM NO.: 571-A Shotcrete * inches Thick - per square yard

Q17: Any additional comments?

Respondent skipped this question

#7

COMPLETE

Collector: Web Link 1 (Web Link)
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Q1: State Representative

Name	Craig S. Knapp
Agency	Caltrans
State / Province	CA
Email	craig_knapp@dot.ca.gov

Q2: Do you a high performance bridge deck mix specification?

If yes, what are the mix design requirements?
Caltrans requires a minimum dosage of shrinkage reducing admixture (SRA), a 28 day shrinkage limit of .032 and a blend of micro and macro polyolifen fibers. Contact me for specifics on SRA dosage, shrinkage and fiber specifications

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
They are required and the percentages vary depending on type of supplementary cementitious used, the aggregate used and the amount of cementitious needed. See Caltrans Standard Specifications.

Q4: Have you used fibers in bridge deck mixes?

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
Polyolefyn. 1 #/CY of micro and 3 #/CY of macro.

Q5: Have you used shrinkage reducing admixtures in bridge decks?

Yes,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
see above

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
Reduced dead load. Dosage depends on density need.

Q7: What are your curing requirements for bridge decks?

Continuous misting from finish strike off until curing medium is applied. Wet cure for 7 days then apply curing compound

Q8: Do you have smoothness requirements for bridge decks?	If yes, what criteria do you use and how is it measured. California Test Method 547 (profilograph). If needed it is available on the internet.
Q9: Do you typically grind bridge decks?	For what reason? Smoothness, Noise, Other? Sometimes grinding is required to reduce noise. Mostly it is used by contractors to meet the profilograph requirements.
Q10: Do you seal bridge decks?	Additional Comments Bridge decks exceeding a certain crack intensity are sealed with methacrylate resin.

Q11: What type of sealers do you allow/specify?

Methylmethacrylate	Allow

Q12: What is the application rate for each sealer?

Methylmethacrylate	Specify
Additional Comments?	90 sf/gal

Q13: What is the typical performance life of a sealed joint?

To date, our assessment is the sealed joint has a longer service life than the surrounding concrete.

Q14: If you seal bridge decks, how often do you retreat?	No

Q15: Please attach a link to approved products list and approval process for joint sealants.

We don't maintain an approved list. See Standard Specs 15-5.05B for material requirements.
http://www.dot.ca.gov/hq/esc/oe/construction_contract_standards/std_specs/2015_StdSpecs/2015_StdSpecs.pdf

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.	If Yes, what is it? See Section 53. http://www.dot.ca.gov/hq/esc/oe/construction_contract_standards/std_specs/2015_StdSpecs/2015_StdSpecs.pdf
Q17: Any additional comments?	*Respondent skipped this question*

CALTRANS REVISIONS TO 201 STANDARD SPECIFICATIONS: **See below revisions to CALTRANS 201 Standard Specifications found here:**
http://www.dot.ca.gov/hq/esc/oe/construction_standards.html

Add to section 51-1.01C(1):

If the methacrylate crack treatment is performed within 100 feet of a residence, business, or public space, submit a public safety plan that includes the following:

1. Public notification letter with a list of delivery and posting addresses. The letter must describe the work to be performed and state the treatment work locations, dates, and times. Deliver the letter to residences and businesses within 100 feet of overlay work and to local fire and police officials not less than 7 days before starting overlay activities. Post the letter at the job site.
2. Airborne emissions monitoring plan. A CIH certified in comprehensive practice by the American Board of Industrial Hygiene must prepare and execute the plan. The plan must have at least 4 monitoring points including the mixing point, application point, and point of nearest public contact. Monitor airborne emissions during overlay activities.
3. Action plan for protecting the public if levels of airborne emissions exceed permissible levels.
4. Copy of the CIH's certification.

After completing methacrylate crack treatment activities, submit results from monitoring production airborne emissions as an informational submittal.

Replace the 2nd paragraph of section 51-1.01C(1) with:

Submit a deck placement plan for concrete bridge decks. Include in the placement plan your method and equipment for ensuring that the concrete bridge deck is kept damp by misting immediately after finishing the concrete surface.

Add to section 51-1.02B:

For the portions of structures shown in the following table, concrete must contain at least 675 pounds of cementitious material per cubic yard:

Bridge name and no.	Portion of structure

For the portions of structures shown in the following table, concrete must contain at least 675 pounds of cementitious material per cubic yard and have air entrainment of __ ± 1.5 percent:

Bridge name and no.	Portion of structure
	All except footings and piles
	All except footings and piles

Air entrainment must be __ ± 1.5 percent for concrete with a compressive strength greater than 4,500 psi.

Use a water-reducing chemical admixture with air-entrained concrete. Chemical admixtures must not cause an increase in drying shrinkage exceeding the limits specified in ASTM C 494. Nominal penetration of concrete must be from ____ to ____ inches.

Concrete in superstructures and barriers for the bridges shown in the table above must:

1. Contain no more than 360 pounds of total water per cubic yard. Total water is the combined total of free water and water absorbed by aggregates in reaching a saturated surface-dry condition.
2. Be prequalified under section 90-1.01D(5)(b). Include water absorbed by the aggregates and free water in the certified test data and trial batch test reports. You must (1) submit a certificate of

compliance for the workability of concrete with the prequalification test reports or (2) demonstrate the workability of trial batches in the Engineer's presence.

If authorized, you may use concrete from trial batches in structures at locations where concrete without a total water requirement is allowed. Concrete from trial batches used in structures at locations where air entrainment is not required must have air entrainment as specified for the trial batch instead of the requirements in section 90-1.02E(3).

For concrete shown with a 28-day compressive strength greater than 3,600 psi:

1. Concrete must contain at least 675 pounds of cementitious material per cubic yard
2. Section 90-1.01D(5)(b) does not apply.

Concrete used in the superstructure of _____ must have air entrainment. The air content after mixing and before placing must be 6.0 ± 1.5 percent.

Aggregate for _____ must be the ____-inch combined aggregate grading complying with section 90-1.02C(4)(d).

Concrete for concrete bridge decks must contain polymer fibers. Each cubic yard of concrete must contain at least 1 pound of microfibers and at least 3 pounds of macrofibers.

Concrete for concrete bridge decks must contain a shrinkage reducing chemical admixture. Each cubic yard of concrete must contain at least 3/4 gallon of a shrinkage reducing admixture. If you use the maximum dosage rate shown on the Authorized Material List for the shrinkage reducing admixture, your submitted shrinkage test data does not need to meet the shrinkage limitation specified.

Replace the 2nd paragraph of section 51-1.03H with:

Cure the top surface of bridge decks by (1) misting and (2) the water method using a curing medium under section 90-1.03B(2). After strike off, immediately and continuously mist the deck with an atomizing nozzle that forms a mist and not a spray. Continue misting until the curing medium has been placed and the application of water for the water method has started. At the end of the curing period, remove the curing medium and apply curing compound on the top surface of the bridge deck during the same work shift under section 90-1.03B(3). The curing compound must be curing compound no. 1.

Delete the 4th paragraph of section 51-1.03H.

Add to section 90-1.01C:

90-1.01C(11) Polymer Fibers

Submit fiber manufacturer's product data and instructions for use.

Submit a certificate of compliance for each shipment and type of fibers.

Replace the row for bridge deck concrete in the table in the 1st paragraph of section 90-1.02A with:

Bridge deck concrete	0.032

Add to section 90-1.02:

90-1.02K Polymer Fibers

Fibers must comply with ASTM D 7508. Microfibers must be from 1/2 to 2 inches long. Macrofibers must be from 1 to 2-1/2 inches long.

IN Ci

Working Knowledge

Concrete shrinkage is not a new problem. J.B. Johnson discussed it in *A Treatise for Engineers on the Strength of Engineering Materials* in 1897. But shrinkage continues to be a timely topic.

Low-shrinkage mixtures are used to minimize curling and thereby help meet the increasing demand for very flat and level industrial floors. As McKinney and Neuber report (p. 29), mixtures with very low paste fractions are common. Combined with highly efficient placing and finishing technologies, however, such mixtures may be contributing to isolated instances of surface distress. Solutions are proposed.

Low-shrinkage mixtures are also used to minimize cracking in bridge decks, with the ultimate goal of boosting service life. As Maggenti, Knapp, and Fereira (p. 36) report, California's department of transportation, Caltrans, has successfully instituted specifications defining shrinkage limits. On the numerous projects cited, contractors have selected shrinkage reducing admixtures to help meet the performance requirements. Both the means and the end are notable.

Many of the factors affecting shrinkage are discussed further in documents produced by ACI committees (Concrete Q&A, p 64). Combined, these articles and documents demonstrate that multiple parameters must be considered toward minimizing shrinkage. No one party can control such complexity, so collaboration among the owner, engineer, supplier, and contractor is essential.

Rex C. Donahey

Controlling Shrinkage Cracking

Available technologies can provide nearly crack-free concrete bridge decks

by Ric Maggenti, Craig Knapp, and Sonny Fereira

It's widely accepted that the durability of structures—particularly concrete bridge decks—will be compromised by the presence of cracks. It's also widely accepted that a major source of cracking is concrete shrinkage. Although research on concrete shrinkage started well over a century ago,[1] our industry has yet to establish a standard and accepted practice for consistently, reliably, and predictably producing concrete structures with minimal or no cracking due to shrinkage stresses. We believe, however, that the industry is on the verge of establishing an accepted practice, coupling newly available tools with an understanding of how various factors impact shrinkage.

Shrinkage Cracking

Shrinkage cracking can have many causes, including:

- Restraint of autogenous and chemical shrinkage strains;
- Strain gradients induced after hardening by hydration heat and surface cooling (thermal strains);
- Strain gradients caused by loss of water to the environment while concrete is fresh (plastic shrinkage); and
- Restraint of drying shrinkage after concrete has hardened (drying shrinkage).

In bridge decks, autogenous, chemical, and thermal effects are generally minor. Also, it's well-established that eliminating evaporation of water from the concrete during and immediately following placement will control and prevent plastic shrinkage. For these reasons, our article focuses solely on drying shrinkage.

Drying Shrinkage Cracking

In his President's Address at ACI's 27th Convention in 1931, Duff A. Abrams observed, "…we shall never have adequate basis for specifications, design, and construction in concrete and reinforced concrete until we develop a sound theory.…[With] a complete theory of concrete we should be able to calculate in advance all properties…"[2] Much has been done toward developing sound theory on drying shrinkage, so we should be able to calculate shrinkage in advance and work to avoid the associated cracking.

In 1930, Davis summarized investigations, dating from the nineteenth century, on moisture and thermal volume changes in concrete.[3] Of the 11 factors he identified as important, many were functions of testing methods, including sample size, durations of wetting and drying, and storage environment for the sample. Five of the 11 factors are most pertinent to modern-day concrete practice:

- Composition and fineness of cement;
- Proportions of cement and aggregate;
- Type and gradation of aggregate;
- Consistency of the mixture (well before today's admixtures, this was a measure of water content); and
- Amount and distribution of reinforcement.

More recent observations have provided detailed evaluations of parameters such as water and paste contents, characteristics of the aggregates, and admixtures.

Water and paste contents

As reported by Carlson,[4] E.N. Vidal and D.O. Ehrenburg at the Denver Laboratory of the Bureau of Reclamation made an early observation that drying shrinkage could be correlated with water content, irrespective of aggregate source, aggregate gradation, cement content, water-cement ratio (*w/c*), or curing duration. Graphs of shrinkage versus water content have since been reprinted in editions of the *Concrete Manual* (at least as early as the sixth edition published in 1956[5]) produced by the Bureau of Reclamation of the U.S. Department of the Interior (Fig. 1).

Tests reported in 1963 by Tremper and Spellman[6] of the California Division of Highways Transportation Laboratory verified Carlson's work. In their tests, mixtures with consistent water content and cement contents ranging from 496 to 754 lb/yd^3 (five to eight sacks or 294 to 447 kg/m^3) exhibited similar shrinkage. The same trend was also shown when comparing mortar containing 752 to 1053 lb/yd^3 (eight to 11 sacks or 446 to 625 kg/m^3) of cement. "Slightly higher" shrinkage was reported only with mixtures with 1270 lb/yd^3 (13.5 sacks or 753 kg/m^3) cement content. The authors also reported that curing beyond 3 days did not

reduce shrinkage—verifying Carlson's findings.[7] It's important to keep in mind, however, that the slumps used in the studies reported in References 4 and 6 were limited by the contemporary placement capabilities and admixtures.

The correlation of water content with drying shrinkage, almost exclusive of other factors, does not conflict with the maxim that concrete shrinkage originates in the paste. It also does not conflict with the observation that paste shrinkage is proportional to the water-cementitious material ratio (*w/cm*) (Fig. 2).

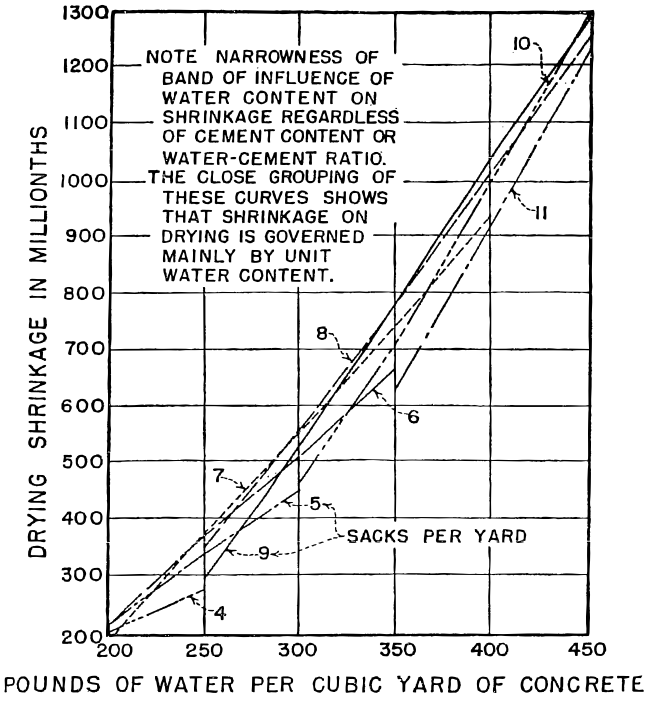

Fig. 1: Influence of water content on drying shrinkage of concrete mixtures with various cement contents[5] (Note: 1 lb/yd³ = 0.6 kg/m³, one sack = 94 lb = 43 kg)

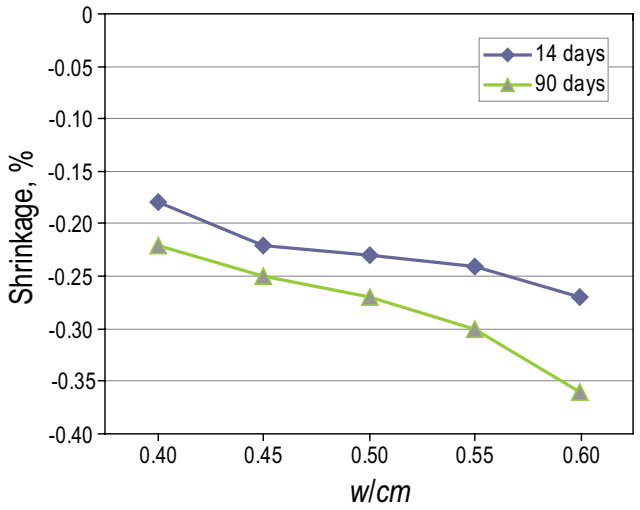

Fig. 2: Effect of *w/cm* on paste shrinkage *(Source: Unpublished Caltrans data used in internal presentations)*

For any given aggregate, slump is a characteristic of water content (excluding the use of admixtures), regardless of paste content. So, if slump is to be held constant, the water must also be held constant. An increase in cement content will thus decrease the *w/c*, paste shrinkage will decrease, and this will offset the increased concrete shrinkage due to the increased paste content (Fig. 3). If more water is added to increase slump and more cementitious material is added to maintain constant *w/cm*, the increased paste content will increase the concrete shrinkage.

Aggregates

Aggregates directly influence drying shrinkage by restraining shrinkage of the paste. This has been verified using concrete specimens with nonabsorbent rubber particles as aggregate having no or little restraint capacity (resulting in shrinkage equal to that of the neat cement).[8] Shrinkage will be a function of the aggregate's stiffness (for a given aggregate size, concrete shrinkage will decrease with increasing aggregate modulus of elasticity) and drying shrinkage (concrete shrinkage will increase with increasing aggregate drying shrinkage). This is not new information. In 1938, for example, Carlson listed the following aggregate types in increasing order of influence on concrete shrinkage: quartz, limestone, granite, basalt, and sandstone.[4,7]

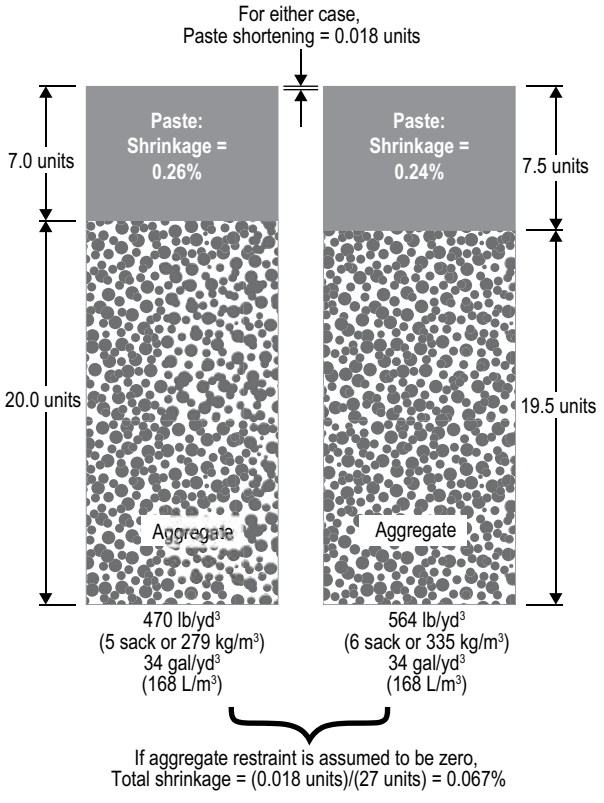

Fig. 3: A hypothetical example showing the counteracting effects of increased cement content with constant water content

The size, shape, and gradation of the aggregates in a mixture also indirectly influence shrinkage by affecting water content and volume of paste in the concrete. Maximizing the amount of aggregate per unit volume of concrete reduces the amount of paste, minimizing the drying shrinking component. Additionally, the aggregate shape affects the amount of water necessary to accomplish the required consistency. For any given *w/c* or *w/cm*, water demand clearly dictates the paste content.

Contamination of aggregate particles with substances such as clay particles can affect water demand and thus increase drying shrinkage. Contamination can also affect the bond of the paste at the aggregate paste interface, directly influencing the aggregate's ability to restrain paste movement.

Setting limits

There has long been evidence suggesting that a target 28-day shrinkage value below 0.030% would significantly limit or eliminate early-age shrinkage cracking. It has also long been known, however, that it would be difficult to achieve a 28-day shrinkage value below 0.030% without transporting specific aggregates to areas where they are not readily available. An 8-year-long study of the Webber Creek Bridge on SR 50 east of Sacramento, CA,[9] for example, evaluated concrete deck sections constructed on steel plate girders with 137 ft (42 m) simple spans.

After 8 years in service, a deck section comprising Type II cement and quartz aggregate had very low amounts of cracking, with only 26 ft (8 m) of soffit cracking. None of these cracks exhibited signs of leakage. The 28-day shrinkage value for the mixture was 0.020% per ASTM C157/C157M, "Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete." In contrast, a similar section comprising a graywacke sandstone mixture exhibited 533 ft (162 m) of soffit cracking, with 18 leaking cracks. The 28-day shrinkage value for the mixture was 0.050% per ASTM C157/C157M.

In a March 1966 study,[7] the California Producers Committee on Volume Change reported that only 5% of the concrete produced would have a 28-day shrinkage value less than 0.030%. It also reported that a 28-day shrinkage value of 0.020% was about the lowest attainable. Even when using good-quality, large aggregate and minimizing water content, low shrinkage values could be achieved only in the best of circumstances.

Efficient means

Today, for a multitude of aggregates and mixture designs, shrinkage-reducing admixtures (SRAs) appear to be an economical and efficient means to achieve a 28-day shrinkage value below 0.030%. SRAs reduce capillary tension in the paste pore water, thereby decreasing shrinkage strains as paste dries.

In 2002, prior to the segmental construction of the Skyway portion of the new east spans of the San Francisco-Oakland Bay Bridge (SFOBB), San Jose State University began investigations of the influence of chemical admixtures on drying shrinkage in high-strength concrete. Testing was performed on over 40 concrete samples and over 80 paste samples, with some measurements continuing after 9 years.[10] Figure 4 summarizes data on 22 concrete mixtures from that investigation. All concrete had a *w/cm* of 0.33 and contained 631 lb/yd^3 (374 kg/m^3) of cementitious material (cement replacements of 20, 25, or 30% with fly ash and 5% with silica fume or metakaolin). Figure 5 illustrates results for paste consisting of portland cement with *w/c* of 0.33 and varying SRA dosages. The effect of SRA on shrinkage is apparent. To show the difference in magnitude

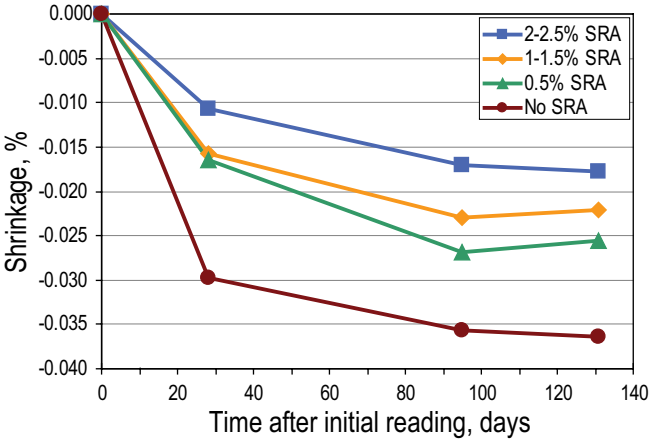

Fig. 4: Concrete shrinkage over time for mixtures with and without SRAs. Data for the control mixture (no SRA) are the averages of four batches. Data for the 0.5% SRA dosage are the averages of five batches. Data for the 1 to 1.5% and 2 to 2.5% SRA dosages represent averages of six batches each. Three shrinkage bars were tested per batch *(Source: Unpublished Caltrans data used in internal presentations)*

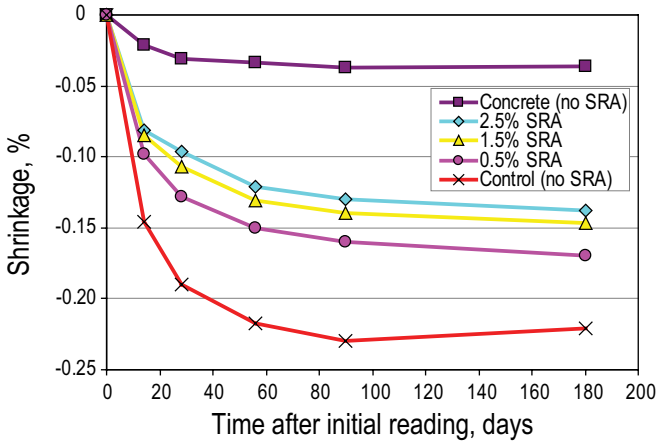

Fig. 5: Effect of SRA dosage on cement paste only, compared with a typical Caltrans high-performance concrete deck mixture *(Source: Unpublished Caltrans data used in internal presentations)*

of paste versus concrete, Fig. 5 includes data for a concrete mixture meeting the California Department of Transportation (Caltrans) bridge deck specification (*w/cm* of 0.34 and 675 lb/yd^3 [400 kg/m^3] of cementitious materials with cement replacements of 25% fly ash and 5% metakaolin).

Given the numerous successful case studies provided by SRA suppliers, and given the positive experiences of Caltrans and other agencies,[11,12] Caltrans has selected SRAs as a method of crack control in cast-in-place decks on precast girders.

Demonstrating success

Between 2001 and 2003, six new bridges with cast-in-place decks on spliced precast bulb-T girders were constructed on I-80 near Truckee, CA. The mixtures had *w/cm* of 0.36, cementitious material contents of 752 lb/yd^3 (446 kg/m^3) with 25% fly ash cement replacement), and 6% air content. Curing was performed according to the Caltrans standard requirements.

After the first few decks were constructed, multiple transverse cracks (on about 2 ft [0.6 m] centers) were visible. Beginning in late summer of 2002, deck mixtures were modified to include SRAs. As shown in Fig. 6, there was a dramatic reduction in cracking. The following construction season, the remaining structures were constructed using an SRA in the deck concrete. The decks constructed using SRAs have remained free of visible cracking.

Following this simple, yet effective, adjustment to the mixture design, specifications were written for the deck mixture for the Angeles Crest Bridge on SR 2 in Los Angeles County, in the mountains northeast of Los Angeles, CA. Specifications called for a 28-day strength of 5000 psi (34.5 MPa) and a 6% air content.

Construction was completed in 2008 using a deck mixture with 767 lb/yd^3 (455 kg/m^3) of cementitious material and SRA. This is a 208 ft (63 m) single-span bridge with the deck cast on six 8 ft (2.4 m) deep spliced precast/prestressed bulb-T girders spaced on 6.5 ft (2 m) centers. Upon later inspection, the bridge maintenance engineer reported: "You appear to have been successful in mitigating the cracking, as the only cracks I could find were some hairline shrinkage cracks at the westerly end." The same result has been achieved on several projects, including the 2007 emergency replacement of the fire-destroyed bridge spans at the MacArthur Maze in Oakland, CA. This replacement was completed in a mere 26 days using a deck mixture comprising SRAs, 800 lb/yd^3 (475 kg/m^3) of cementitious material, water reducers, and a Type C accelerating admixture. The deck was cast on steel girders with headed studs for composite action. No cracking has yet been reported on this replacement deck span, while transverse cracks have been noted every few feet on all adjacent deck spans. The original spans used a six-sack (564 lb/yd^3 [335 kg/m^3]) mixture with 1.5 in. (38 mm) maximum nominal aggregate. These projects demonstrated that SRAs could eliminate the need to specify low-strength concrete, long curing times, a low *w/cm*, or large aggregates.

"Deck-on-deck" rehabilitation of the Pit River Bridge on I-5 over Shasta Lake, CA, in 2007 permitted evaluation of several mixture designs, including combining SRA with fibers. Deck-on-deck construction is especially prone to cracking due to drying shrinkage stresses. Relying upon our earlier experience of using SRAs to reduce early-age deck cracking and several previous successful applications of synthetic polyolefin macrofibers to restrain plastic and drying shrinkage cracking, the two technologies were combined for a "crackless" concrete deck (771 lb/yd^3 [8.2 sacks or 457 kg/m^3] of cement, 6% air, *w/c* of 0.51, SRA at 0.75 to 1.5 gal./yd^3 [3.7 to 7.4 L/m^3], and fibers at 3 lb/yd^3 [1.8 kg/m^3]). After 5 years of service, sections of the deck comprising both SRA and fibers exhibited very limited cracking. Cores taken at cracked locations indicated that cracks were very thin and most were arrested near the surface. Two cores extracted at full-depth (4 in. [102 mm]) crack locations showed finelined cracks kept intact by the

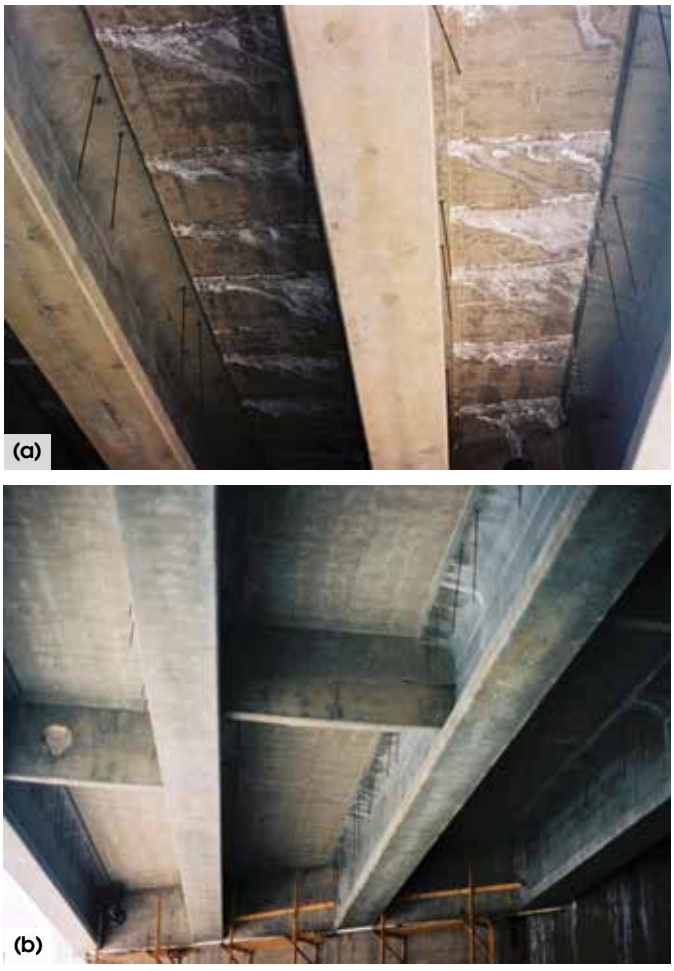

Fig. 6: Cast-in-place decks and spliced precast bulb-T girders on I-80 near Truckee, CA: (a) deck constructed without SRA; and (b) deck constructed with SRA *(photos courtesy of Ric Maggenti)*

fibers. In contrast, the control sections of the deck, placed without SRA and without fibers, exhibited substantial cracking within 6 weeks.

In 2011, a 5 in. (127 mm) "crack-free" deck was placed on precast box beams over Craig Creek on SR 99 near Red Bluff, CA. The concrete mixture was designed to develop a 3-day strength of 4000 psi (27.6 MPa), using 705 lb/yd^3 (418 kg/m^3) portland cement (*w/c* of 0.39), SRA (0.75 gal./yd^3 [3.7 L/m^3]), and synthetic macrofibers (3 lb/yd^3 [1.8 kg/m^3]). The project was used to study accelerated bridge construction via high-performance concrete and limited time (only 3 days) for moist curing. No visible cracking was noted during inspection after 14 months of service. It was concluded that a high-quality, durable deck can be successfully and rapidly constructed.

A concrete mixture comprising SRA and fibers was also used to construct the roof of a maintenance station on the Doyle Drive project in San Francisco, CA. The completed deck also serves as the invert of the project's tunnel. The deck was found to be crack-free 6 months after construction.

The effectiveness of SRAs in mitigating shrinkage cracking was also demonstrated on 1 ft (0.3 m) thick concrete encasement jackets placed around steel footing boxes on the Skyway portion of the new east spans of SFOBB. Impressively, there were no cracks, even at the reentrant corners (Fig. 7), several months after construction. SRA was also used successfully in the project's pile caps.

Fig. 7: Concrete footing jacket on the skyway portion of the new span for the SFOBB: (a) stay-in-place steel forms with headed studs; and (b) finished jacket, exhibiting no visible cracks *(photos courtesy of Bill Lee and Ric Maggenti)*

Ongoing Needs

Tens of thousands of cubic yards of high-strength concrete have been supplied with SRAs to meet the Caltrans shrinkage performance requirements of 0.030% at 28 days and 0.045% at 180 days. Segmental bridges such as Confusion Hill; Devil's Slide; the Spanish Creek Spandrel Arch Bridge in Plumas County, CA, on SR 70; and the two large box girder bridges of the east spans of the SFOBB have been constructed under a performance specification for shrinkage. In all cases, the contractors elected to use SRAs to meet the shrinkage performance requirements. In the latter case, only 0.5 gal./yd^3 (2.5 L/m^3) of SRA was used, yet the mixture exhibited 28-day shrinkage values of only about 0.020%.

It should be noted that the SFOBB projects were in an area with high-quality aggregates (which were absolutely necessary to produce the specified high-performance concrete). In locations where aggregate quality is very poor, it may be necessary to use SRAs in addition to other practices, such as using larger maximum size aggregate, to reduce water demand and control drying shrinkage.

While it is also possible to use methacrylate treatments to fill and seal cracks, the preparation and application costs for these treatments are more than double the costs for an effective dosage of SRA and fibers. Therefore, preventing cracks is a more cost-effective solution.

Bases for Success

As Bryant Mather wrote in 1951: "…concrete research has value and meaning only as it improves the quality, economy, and applicability of concrete for construction…"[13] Research and experience has convincingly demonstrated that early-age shrinkage cracking in concrete bridge decks can be significantly reduced if the mixtures have 28-day shrinkage values below 0.030%. While controlling drying shrinkage to these levels previously required use of low-slump mixtures and large, dense aggregates, it is now possible to do so using SRAs, water reducers, and fibers. With a sound theoretical basis, we believe that SRA mixtures satisfy Abram's key requirement for the control of concrete behavior. With the associated improvements in quality and economy, we also believe the research behind these mixtures meets Mather's requirements for value and meaning.

Acknowledgments

The authors wish to recognize the generation of leaders that we followed for their contributions to the body of materials science, immense construction engineering knowledge, and contagious knack for inspiring scientific study. While this list is large, some former

Caltrans engineers are at the top of our list: James E. Roberts, L. Edwin Dunn, Leo R. Ferroni, Bert P. Bezzone, Loren L. Krueger, and David K. DeFoe. Importantly in the civil service arena, they accomplished their missions and made their careers by balancing risks necessary for pioneering advancements in modern engineering methods with the responsibility and incontrovertible duty to keep and protect the public trust.

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Selected for reader interest by the editors.

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Craig Knapp is a Senior Bridge Engineer with Caltrans. He received his BS in mechanical engineering from Clarkson University, Potsdam, NY, and his MS in engineering and MBA from California Polytechnic State University, San Luis Obispo, CA. He previously worked for Hunt Engineers, Architects and Land Surveyors, Big Flats, NY. He is currently focused on specification and workforce development for Caltrans Structure Construction and is adjunct faculty for the Sacramento State University Construction Management Department.

Sonny Fereira is an Area Bridge Construction Engineer with Caltrans. He received his BS in civil engineering in 1983 from California State University, Chico, CA. A professional engineer in California, Fereira has worked for Caltrans since 1980.

#3 COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, March 15, 2016 11:15:05 AM
Last Modified: Tuesday, March 15, 2016 11:21:57 AM
Time Spent: 00:06:51
IP Address: 63.225.17.34

PAGE 1

Q1: **State Representative**

Name	Eric Prieve
Agency	Colorado DOT
State / Province	CO
Email	Eric.Prieve@state.co.us

Q2: **Do you a high performance bridge deck mix specification?**

If yes, what are the mix design requirements?
Class H concrete is used for bare concrete bridge decks. Additional requirements are: (1) Type A or dual rated Type A and F chemical admixtures may be used. (2) Set retarding and accelerating admixtures shall not be used. These include Type B, C, D, E, and G chemical admixtures. (3) The concrete mix shall consist of a minimum of 55 percent sizes No. 57, No. 6, or No. 67 coarse aggregate by weight of total aggregate. (4) The permeability of the laboratory trial mix shall not exceed 2000 coulombs at 56 days when tested by ASTM C 1202 (5) The cracking tendency of the laboratory trial mix shall not exhibit a crack before 15 days when tested by AASHTO T334. (6) Class H concrete shall contain a minimum of 20 percent pozzolan by weight of total cementitious material. (7) The sulfate exposure is Class 0 except when substituted for Class B or D concrete.

Q3: **Do you allow supplementary cementitious materials in bridge deck mixes?**

Yes,

If yes, what types? What percentage? Please be as specific as you can.
Class H concrete shall contain a minimum of 20 percent pozzolan by weight of total cementitious material.

Q4: **Have you used fibers in bridge deck mixes?**

No

Q5: **Have you used shrinkage reducing admixtures in bridge decks?**

No

Q6: **Have you used lightweight aggregate in bridge deck mixes?**

No

Q7: What are your curing requirements for bridge decks?

Water Cure Method. The water cure method shall be applied as soon as it can be without marring the surface. The surface of the concrete, including bridge curbs and bridge sidewalks, shall be entirely covered with wet burlap and polyethylene sheeting. Prior to being placed, the burlap shall be thoroughly saturated with water. The wet burlap and polyethelene sheeting shall extend at least twice the thickness of the bridge deck beyond the edges of the slab and shall be weighted to remain in contact with the surface. The wet burlap and polyethylene sheeting shall remain in contact and be kept wet for the entire curing period

Q8: Do you have smoothness requirements for bridge decks?	No
Q9: Do you typically grind bridge decks?	No
Q10: Do you seal bridge decks?	Additional Comments All new bridge decks will have a water proofing layer on top of the concrete. Either polyester concrete or an asphalt membrane covered by HMA.

Q11: What type of sealers do you allow/specify?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow

Q12: What is the application rate for each sealer?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow

Q13: What is the typical performance life of a sealed joint?	*Respondent skipped this question*
Q14: If you seal bridge decks, how often do you retreat?	No
Q15: Please attach a link to approved products list and approval process for joint sealants.	*Respondent skipped this question*
Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.	If Yes, what is it? https://www.codot.gov/business/designsupport/2011-construction-specifications/2011-Specs/2011-specs-book/section_600.pdf/view Section 641
Q17: Any additional comments?	*Respondent skipped this question*

#2 COMPLETE

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PAGE 1

Q1: State Representative

Name	Bouzid Choubane
Agency	DOT
State / Province	Florida
Email	bouzid.choubane@dot.state.fl.us

Q2: Do you a high performance bridge deck mix specification?

If yes, what are the mix design requirements?
The mix is required to have fly ash or slag in addition to a minimum 658# cementitious materials, w/c+b less than or equal to 0.41, all materials are approved and on the list of approved sources. Bridge decks are required to have 7 days of moist curing, with a curing compound applied after the moist curing.

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
Fly ash - 18 to 22% Slag - 50 to 70% High reactive pozzolans may be used to provide additional strength and durability but are not required unless the bridge deck is with in 12' if MHW in an extremely aggressive environment. This would be considered high chlorides, high sulfates, low pH, and low resistivity.

Q4: Have you used fibers in bridge deck mixes?

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
Polypropylene and basalt.

Q5: Have you used shrinkage reducing admixtures in bridge decks?

Yes,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
We have several SRA's approved. We state that the SRA should be used at the manufacturer's recommended dosage rate.

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
We have used the light weight in bridge girders and decks, primarily to reduce dead load. The aggregate was used as a 20% replacement in the girders and the deck applications.

Q7: What are your curing requirements for bridge decks?

7 days moist-cure followed by curing compound.

Q8: Do you have smoothness requirements for bridge decks?

If yes, what criteria do you use and how is it measured.
We grove and grind our decks to get a smooth ride and a higher friction number. The requirement the surface cannot exceed 1/8th inch in 10' using the 10' straightedge, or a rolling straight edge. With the California Profilograph, on a tangent alignment of 2,000 feet or more the PI should be 5 inches per mile or less, for centerline radius of more than 1,000 feet but less than 2,000 feet, the PI should be 7 inches per mile or less. The pavement must have all deviations or 0.3 in. in 25 feet removed.

Q9: Do you typically grind bridge decks?

Yes

Q10: Do you seal bridge decks?

It depends

Q11: What type of sealers do you allow/specify?

Methylmethacrylate — Specify

Q12: What is the application rate for each sealer?

Methylmethacrylate — Specify

Additional Comments? — Per manufacturer's recommendation.

Q13: What is the typical performance life of a sealed joint?

It depends the traffic level. On interstate we probably get 10 years. The pavement is ususally milled and resurfaced and sealing the bridge joints is part of the contract.

Q14: If you seal bridge decks, how often do you retreat?

If Yes, what is it? Does your Agency retreat or do you let a Contract for the work?
7 to 10 years

Q15: Please attach a link to approved products list and approval process for joint sealants.

Respondent skipped this question

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.

Yes

Q17: Any additional comments?

For additional information, please contact Michael Bergin at Michael.bergin@dot.state.fl.us

#28

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, April 08, 2016 11:07:28 AM
Last Modified: Friday, April 08, 2016 11:21:00 AM
Time Spent: 00:13:32
IP Address: 70.193.171.147

PAGE 1

Q1: **State Representative**	
Name	Jason Waters
Agency	Department of Transportation
State / Province	Georgia
Email	jwaters@dot.ga.gov
Q2: **Do you a high performance bridge deck mix specification?**	No
Q3: **Do you allow supplementary cementitious materials in bridge deck mixes?**	It depends, If yes, what types? What percentage? Please be as specific as you can. Flyash up to 15% Slag up to 50%
Q4: **Have you used fibers in bridge deck mixes?**	No
Q5: **Have you used shrinkage reducing admixtures in bridge decks?**	No
Q6: **Have you used lightweight aggregate in bridge deck mixes?**	Yes, If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can. Dead load
Q7: What are your curing requirements for bridge decks?	*Respondent skipped this question*
Q8: **Do you have smoothness requirements for bridge decks?**	Yes
Q9: **Do you typically grind bridge decks?**	For what reason? Smoothness, Noise, Other? Depends on the ride
Q10: **Do you seal bridge decks?**	Additional Comments Only if there are steel cover issues.

Q11: **What type of sealers do you allow/specify?**	
Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Allow
Q12: What is the application rate for each sealer?	*Respondent skipped this question*
Q13: What is the typical performance life of a sealed joint?	*Respondent skipped this question*
Q14: **If you seal bridge decks, how often do you retreat?**	If Yes, what is it? Does your Agency retreat or do you let a Contract for the work? Manufacturers recommendation
Q15: Please attach a link to approved products list and approval process for joint sealants.	*Respondent skipped this question*
Q16: **Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.**	Yes
Q17: Any additional comments?	*Respondent skipped this question*

#18

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, April 01, 2016 10:32:09 AM
Last Modified: Monday, April 04, 2016 2:37:23 PM
Time Spent: Over a day
IP Address: 164.165.251.4

PAGE 1

Q1: State Representative

Name	Clint Hoops
Agency	Idhao Transportation Dept.
State / Province	Idaho
Email	Clint.Hoops@itd.idaho.gov

Q2: Do you a high performance bridge deck mix specification?

No

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
25% Class F Fly ash 30% Slag Cement 10% Silica Fume With ternary blend no more than 50% SCM

Q4: Have you used fibers in bridge deck mixes?

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
Varies, Typically macro fibers at 2lbs. yard

Q5: Have you used shrinkage reducing admixtures in bridge decks?

No

Q6: Have you used lightweight aggregate in bridge deck mixes?

No

Q7: What are your curing requirements for bridge decks?

10 day water cure

Q8: Do you have smoothness requirements for bridge decks?

It depends

Q9: Do you typically grind bridge decks?

No

Q10: Do you seal bridge decks?

It depends

Q11: What type of sealers do you allow/specify?

Silane	Specify
Siloxane	Specify
Methylmethacrylate	Specify
Epoxy Chip Seal	Specify
Polymer Modified Overlay	Specify
Additional Comments?	Products may be specified on a project by project basis.

Q12: What is the application rate for each sealer?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Allow
Additional Comments?	Application rates are generally per manufactures recommendations. Poly Modified - 1 to 2inches.

Q13: What is the typical performance life of a sealed joint?

Respondent skipped this question

Q14: If you seal bridge decks, how often do you retreat?

Respondent skipped this question

Q15: Please attach a link to approved products list and approval process for joint sealants.

http://materials/SearchByCat.aspx

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.

No

Q17: Any additional comments?

Respondent skipped this question

#16 COMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, April 01, 2016 2:35:47 PM
Last Modified: Friday, April 01, 2016 3:11:13 PM
Time Spent: 00:35:25
IP Address: 163.191.13.70

PAGE 1

Q1: State Representative

Name	James Krstulovich
Agency	Illinois DOT
State / Province	Illinois
Email	James.Krstulovich@illinois.gov

Q2: Do you a high performance bridge deck mix specification?

No

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
Fly Ash: Class C up to 30%; Class F up to 25% GGBF Slag up to 35% Microsilica up to 5.0% High-Reactivity Metakaolin up to 5.0% Ternary mixes allow up to 35% replacement total, with the individual SCM components limited to the above max percentages. If necessary to mitigate ASR, options are available to use a minimum 25.0% fly ash or slag.

Q4: Have you used fibers in bridge deck mixes?

No,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
We are starting to use them in bridge deck overlays. Typical dosage rate is 2.0-3.0 pcy of synthetic macro-fibers (Type III according to ASTM C1116). For our bridge deck latex overlays, the typical dosage rate is about 2.0 pcy of Type II or III synthetic fibers according to C1116.

Q5: Have you used shrinkage reducing admixtures in bridge decks?

Yes,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
SRAs have only been used in two DOT decks and one local agency project so far. Typical dosage between 1-2 gal/cu.yd according to manufacturer's recommendation to achieve no more than 0.030% shrinkage according to ASTM C157 (determined after 7-day cure and 28 days of drying).

Q6: **Have you used lightweight aggregate in bridge deck mixes?**	Yes, If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can. So far only to reduce dead load on bridges; however, we will be trying internal curing during 2016 and 2017 construction seasons.

Q7: **What are your curing requirements for bridge decks?**

7 days wet with wetted cotton mats or cellulose polyethylene curing mats.

Q8: **Do you have smoothness requirements for bridge decks?**	No
Q9: **Do you typically grind bridge decks?**	It depends
Q10: **Do you seal bridge decks?**	Additional Comments We have some guidelines for routinely sealing bridge decks; however, it may not be widespread and it may depend significantly on available maintenance monies.

Q11: **What type of sealers do you allow/specify?**

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Do not use
Epoxy Chip Seal	Do not use
Polymer Modified Overlay	Specify
Other	Allow
Additional Comments?	Our most commonly used sealer is a protective coat (boiled linseed oil) meeting the requirements of AASHTO M 233, except the nonvolatile range shall be 53-57% and the petroleum spirits used shall be Type I (ASTM D235) with a max copper corrosion rating of 2. Allowable sealers shall be listed in AASHTO M 224. Other allowable sealers on our approved list are silica, oxaluminum stearate, isorproponal, and epoxy types. (The epoxy types are film forming and are allowed on non-traffic areas only.) Though listed in M 224, methylmethacrylate sealers are not allowed for safety reasons.

Q12: What is the application rate for each sealer?

Additional Comments?	Typical application rates single applications between 100-400 sq.ft/gal. Specific products and their max application rates can be found on our approved list: http://www.idot.illinois.gov/Assets/uploads/files/Doing-Business/Specialty-Lists/Highways/Materials/Materials-&-Physical-Research/Concrete/concretesealers.pdf
Q13: What is the typical performance life of a sealed joint?	*Respondent skipped this question*
Q14: If you seal bridge decks, how often do you retreat?	If Yes, what is it? Does your Agency retreat or do you let a Contract for the work? Guidelines recommend retreating every 4 years. Treatment can be contracted or done by DOT maintenance forces.
Q15: Please attach a link to approved products list and approval process for joint sealants.	*Respondent skipped this question*
Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.	Yes
Q17: Any additional comments?	*Respondent skipped this question*

#15

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Wednesday, March 23, 2016 3:06:36 PM
Last Modified: Wednesday, March 23, 2016 3:23:33 PM
Time Spent: 00:16:56
IP Address: 163.191.102.70

PAGE 1

Q1: State Representative

Name	Steve Gillen
Agency	Illinois Tollway
State / Province	IL
Email	sgillen@getipass.com

Q2: Do you a high performance bridge deck mix specification?

If yes, what are the mix design requirements? Requirements are based on performance, not prescription. See provided special provision for detail.

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
No limits on type or percentage since specification is performance based. See special provision.

Q4: Have you used fibers in bridge deck mixes?

No

Q5: Have you used shrinkage reducing admixtures in bridge decks?

Yes,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
Of the 60+ decks built with mixes containing SRA's the performance has been outstanding with most all bridges having no shrinkage cracks. Typical dosages have been 1.5 gallons per cubic yard. Suppliers prefer the use of SRA's over lightweights because of the easier use of SRA's during production.

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
The contractors are given the option to produce their HPC mixes with either SRA's, lightweights, or a combination of both to meet specifications for reduced shrinkage crack potential. All three options have been used. Typical dosage of lightweights has been 364 to 395 lbs. per cu. yd.

Q7: What are your curing requirements for bridge decks?

4 day wet cure on a deck with internally cured concrete. 7 day wet cure for all other decks.

Q8: Do you have smoothness requirements for bridge decks?	If yes, what criteria do you use and how is it measured. Only a 10 ft. straightedge is used to measure smoothness. Stricter specs are needed.
Q9: Do you typically grind bridge decks?	No
Q10: Do you seal bridge decks?	Additional Comments Only on bridges constructed within the last 11 years are sealed as part of a preservation program.

Q11: What type of sealers do you allow/specify?

Silane	Specify
Siloxane	Specify
Methylmethacrylate	Allow
Q12: What is the application rate for each sealer?	*Respondent skipped this question*

Q13: What is the typical performance life of a sealed joint?

If you are referring to rubber seals, the expansion joints only last 10 to 15 years before a new neoprene seal and possibly concrete nosing repairs are needed.

Q14: If you seal bridge decks, how often do you retreat?	If Yes, what is it? Does your Agency retreat or do you let a Contract for the work? It is unknown at this time because the preservation work is dependent on maintenance and operation budgets that can vary per year. We let a contract for the work.

Q15: Please attach a link to approved products list and approval process for joint sealants.

We refer to the IDOT approval list and specifications for strip seals and only allow two products to be used for fillers (Jeene & D.S. Brown products).

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.	If Yes, what is it? Wet process.

Q17: Any additional comments?

Special provisions will be sent to Denise by separate email.

BONDED PREFORMED JOINT SEAL (Tollway GBSP)

Effective: May 24, 2006
Revised: July 23, 2013

DESCRIPTION

This work shall consist of furnishing all labor, equipment, technical assistance and materials necessary to install the bonded preformed joint seal as shown on the plans and as specified herein.

When specified, an elastomeric concrete nosing compatible with the preformed seal as required by the sealant manufacturer shall be installed. The minimum dimensions for a polymer concrete nosing cross section are 1 1/2 in. deep by 3 1/2 in. wide. The elastomeric concrete shall be furnished and installed according to the Tollway Special Provision for "Bridge Expansion Joints, Replacement and Reconstruction, with Bonded Preformed Seals and Elastomeric Concrete ".

MATERIALS

Joint seals used for the replacement and reconstruction of the existing seals shall consist of the pre-formed neoprene pressurized seals of the JEENE Joint Seal System as manufactured by Watson, Bowman, Acme, Corp., and/or of the pre-formed neoprene compression seals of the J-Series Joint Seal System as manufactured by D. S. Brown Company. Only the following materials supplied by Watson, Bowman, Acme or D. S. Brown shall be used to install the joint seal systems.

(1) Alternate "A": JEENE Joint System. A polychloroprene (neoprene) elastomer seal, preformed by extrusion and vulcanized into its definitive shape, which is supplied in several configurations and dimensions, ranging from ¼" to 5" shall be required for use. The preformed seal shall have the following properties:

PROPERTY	**ASTM METHOD**	*REQUIREMENT*
Tensile Strength, min.	D-412	2000 psi (13.8 Mpa)
Elongation at Break, min.	D-412	250%
Hardness, Shore A	D-2240	65 ± 5
Oven Aging, 70 hrs. at 212ºF Tensile Strength, max. loss Elongation at Break, max. loss Change in Hardness	D-573	 20% 20% 0 – 10 points
Oil Swell, 70 hrs. at 212ºF Weight Change, max.	D-471	 45%
Ozone Resistance, 70 hrs. at 104ºF	D-1149	No Cracks
Low Temperature Stiffing, 7 days at 14ºF Change in Hardness	D-2240	0 – 15 points

A two-component, thixotropic, epoxy-based adhesive, which is mixed at the job site and supplied by the joint seal manufacturer, shall be required for use with the JEENE Joint Seal System. The adhesive shall have the following properties:

PROPERTY	**ASTM METHOD**	REQUIREMENT
Tensile Strength	D-638	4,000 psi
Axial Compression	D-638	8,000 psi
Pot Life at 68ºF	N/A	40 minutes
Flash Point	N/A	> 200ºF
Initial Cure at 68ºF	N/A	24 hours
Full Cure at 68ºF	N/A	7 days

Note: If the ambient air temperature is between 40ºF and 60ºF, an alternate cold weather epoxy shall be utilized.

(2) Alternate "B": J-Series Joint Seal System. A polychloroprene (neoprene) elastomeric seal preformed by extrusion and vulcanized into its definitive shape, ranging from 1" to 4" shall be required for use. The preformed seal shall have the following properties:

PROPERTY	**ASTM METHOD**	**REQUIREMENT**
Tensile Strength, min.	D-412	2000 psi
Elongation at Break, min.	D-412	250%
Hardness, Shore A	D-2240	55 ± 5
Oven Aging, 70 hrs. @ 212°F Tensile Strength, max. loss Elongation at Break, max. loss Change in Hardness, Shore A		 20% 20% 0 – 10 points
Oil Swell, 70 hrs at 212°F Weight Change, max.	 D-471	 45%
Ozone Resistance, 20% strain, 70 hrs aging, D573, 3 ppm in air	D-1149	No Cracks

A two-component modified epoxy-based adhesive, which is mixed at the job site and supplied by the joint seal manufacturer, shall be required for use with the J-Series Joint Seal System. The adhesive shall have the following properties:

PROPERTY	**ASTM METHOD**	**REQUIREMENT**
Tensile Strength, min.	D-638	4,500psi, min.
Axial Compression	D-638	8,775 psi, min.
Pot Life at 68°F	N/A	45 minutes
Flash Point	N/A	>200°F
Non-Volatile content		100% reactive
Initial cure @ 70°F	N/A	24 hours

CONSTRUCTION REQUIREMENTS

General. Technical assistance provided by the manufacturer during surface preparation and installation shall be furnished at no additional cost to the Tollway. The Contractor shall furnish the Engineer with the manufacturer's written product information, installation procedures, and instructional video at least two weeks prior to installation. The Contractor, the manufacturer's representative, and the Engineer shall meet to review and clarify installation procedures, and requirements prior to starting the work. A technical representative must be present for the start of surface preparations and installation for at least one day. The Contractor shall contact the manufacturer at least two weeks prior to installation.

Installation. When placing the bonded preformed joint seal against concrete, the concrete surface shall be dry. For newly placed concrete, the concrete shall be fully cured and allowed to dry out a minimum of 7 additional days prior to placement of the bonded preformed joint seal. Cold, wet, inclement weather will require an extended drying time.

Joint Seal System Installations. Joint seal installations shall be as follows.

(1) JEENE Joint Seal System Installation. After the elastomeric concrete or Portland cement nosing material has cured and the joint opening form has been removed, (and after the Engineer verifies that work done under other subsections meets requirements,) the pre-formed neoprene pressurized seal shall be installed. Before installation of the seal, the entire formed joint opening shall be cleaned with all foreign materials totally removed from the gap. The environment should be free of dust, oil, grease, wax, moisture, and frost. The elastomeric concrete heads must first be cleaned out by disc grinding or sandblasting using black beauty sand and then vacuumed or blown with dry, oil free, compressed air before the two component epoxy adhesive is mixed and applied. No installation may be performed in rainy weather, or when rain is expected within one hour before installation. All surfaces must be completely dry prior to applying adhesive.

The pre-formed neoprene pressurized seals shall be of the size and shape shown on the Plans. Ambient temperature shall not be lower than 40ºF during installation. Note that gap size will change with cold and hot temperature extremes. Gap measurement should optimally be carried out at the mid-point of the average temperature range for the area of installation. The pre-formed seal shall be cut to the correct length of the appropriate gap for installation, without pulling or exerting excess tension. After the seal length is determined and required cut-outs are completed, both ends of the seal shall be plugged (air tight) and the air valves installed. All end plugs in the seal shall be tested for air tightness and integrity by careful inspection and water submergence prior to seal installation in the joint opening. Deflate and dry off the pre-formed seal before installation.

Clean and abrade the sides of the pre-formed seal per the manufacturer's instructions before the epoxy adhesive is applied. Mix adhesive according to manufacturer's directions only after all preparation of the joint openings in all lanes and for the pre-formed seal are complete. The adhesive shall be applied to the inner faces of the joint opening in an even manner, without leaving blank spots. In the same even manner, the adhesive shall be applied to the outer rigid side walls of the pre-formed seal. As the adhesive is applied to the seal walls (on both sides), the seal should be gradually inserted into the gap, without stress or compression. The contractor should maintain the profile at the depth desired, by hand or by any convenient means. The seals shall be

installed at all times with the top of the seal placed below the top of the seal placed below the top of the adjoining pavement slabs as shown on the Plans. Any excess adhesive shall be removed.

Pressurization should be done through the air valve with a heavy pump. Pressurization should be applied slowly so as not to cause the joint to squeeze adhesive out of the flanges on the sides of the joint. Following pressurization, immediately clean all excess adhesive around the edges and top of the joint with a trowel or scraping tool, allow the epoxy adhesive to cure approximately 24 hours, and then remove the air valve to bleed off air pressure.

(2) J-Series Joint Seal System Installation. After the elastomeric concrete or Portland cement nosing material has cured and the joint opening form has been removed (and after the Engineer verifies that work done under other subsections meets requirements), the pre-formed neoprene compression seal shall be installed. Before installation of the seal, the entire formed joint opening shall be cleaned with all foreign materials totally removed from the gap. The environment should be free of dust, oil, grease, wax, moisture, and frost. The elastomeric concrete heads must first be cleaned using a stiff bristled brush or sandblasting using black beauty sand and then vacuumed or blown with dry, oil free, compressed air before the two component epoxy adhesive is mixed and applied. No installation may be performed in rainy weather, or when rain is expected within one hour before installation. Clean the concrete surfaces with alcohol cleaner and all surfaces must be completely dry prior to applying adhesive.

The pre-formed neoprene compression seals shall be of the size and shape shown on the Plans. Uncoil the seal and allow it to relax. Apply seal conditioner, scrubbing vigorously into the ribs of the seal using a wire brush or wire wheel on the sidewalls. The surface must be abraded and tacky to the touch. This roughened, dull finish is needed for an aggressive bond. Continued scrubbing with a stiff nylon brush and new conditioner will clean the surface. Do this in two separate passes, and then rinse the profile with cleaner.

Apply the adhesive to the joint surfaces and into the ribs of the profile using a margin trowel. The ribs must be completely filled. Using a vacuum hooked up to one end of the seal length, draw down the seal enough to insert into the opening. One placed and leveled, turn off vacuum pump and allow the seal to expand and push against the concrete. A small amount of adhesive should be visible above the ribbed area. Remove any additional adhesive using organic solvents. Allow the adhesive to cure for 24 hours.

METHOD of MEASUREMENT

This work will be measured in place, in feet along the centerline of the joint.

BASIS of PAYMENT

This work will be paid for at the contract unit price per foot for BONDED PREFORMED JOINT SEAL, of the size specified. The size is defined as the joint opening at 50°F. When an elastomeric concrete nosing is specified it shall not be included in this item but will be paid for according to the Tollway Special Provision for “Bridge Expansion Joints, Replacement and Reconstruction, with Bonded Preformed Seals and Elastomeric Concrete ".

Pay Item Number	Designation	Unit of Measure
JT525135	BONDED PREFORMED JOINT SEAL, 4 IN.	FOOT

PERFORMANCE-RELATED SPECIAL PROVISION FOR HIGH PERFORMANCE CONCRETE MIX DESIGNS FOR CONCRETE SUPERSTRUCTURE (Tollway)

Effective: October 12, 2012
Revised: September 11, 2015

DESCRIPTION

This work consists of designing and furnishing high performance portland cement concrete. The objective of this performance-related special provision is to provide the Illinois Tollway with a methodology to assure high quality concrete with reduced shrinkage potential, while simultaneously allowing the Contractor the maximum freedom in deciding how to develop the mix design and place the concrete to achieve this objective. Construction of superstructures using high performance concrete shall be in accordance with Section 503 of the IDOT Standard Specifications except where modified by this special provision.

REFERENCE STANDARDS

Except where modified by the Illinois Department of Transportation or the Tollway, the following Standards shall apply:

Illinois Department of Transportation (IDOT)

- Standard Specifications for Road and Bridge Construction, Adopted January 1, 2012.
- Supplemental Specifications and Recurring Special Provisions, Current Edition.
- Test Procedures referenced herein, as described in the current edition of the Manual of Test Procedures for Materials, as well these test procedures:

    - AASHTO T 22 Compressive Strength of Cylindrical Concrete Test Specimens
    - AASHTO T 105 Chemical Analysis of Hydraulic Cement
    - AASHTO T 119 Standard Test Method for Slump of Hydraulic-Cement Concrete
    - AASHTO T 152 Air Content of Freshly Mixed Concrete by the Pressure Method
    - AASHTO T 160 Length Change of Hardened Hydraulic-Cement Mortar and Concrete
    - AASHTO T 161 Standard Method of Test for Resistance of Concrete to Rapid Freezing and Thawing (Procedure A – modified)
    - AASHTO T 277 Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration
    - AASHTO T 303 Potential alkali reactivity of aggregates (mortar-bar method)
    - ASTM A820 Standard Specification for Steel Fibers for Fiber-Reinforced Concrete
    - ASTM C94 Standard Specification for Ready-Mixed Concrete
    - ASTM C457 Microscopical Determination of Parameters of the Air-Void System in Hardened Concrete (Method B)
    - ASTM C494 Standard Specification for Chemical Admixtures for Concrete
    - ASTM C856 Petrographic Examination of Hardened Concrete

- ASTM C1581 Determining Age at Cracking and Induced Tensile Stress Characteristics of Mortar and Concrete under Restrained Shrinkage
- ASTM C1666 Standard Specification for Alkali Resistant (AR) Glass Fiber for GFRC and Fiber-Reinforced Concrete and Cement
- ASTM C1761 Standard Specification for Lightweight Aggregate for Internal Curing of Concrete
- ASTM D7508 Standard Specification for Polyolefin Chopped Strands for Use in Concrete

MATERIALS

Portland cement, mixing water, fine and coarse aggregates, supplementary cementitious materials, and concrete admixtures shall conform to the requirements of Section 1000 of Illinois Department of Transportation *Standard Specifications for Road and Bridge Construction*, Current Edition, with exceptions as noted. Specific references are as follows:

Material	Section
Cement (See Note 1)	1001
Mixing Water	1002
Fine Aggregates (See Note 2)	1003
Coarse Aggregates (See Note 2)	1004
Supplementary Cementitious Materials (See Note 3)	1010
Concrete Admixtures (See Note 4)	1021
Other Materials	see Notes 5 and 6

- Note 1: Portland cement shall be according to AASHTO M 85 and blended cement shall be according to AASHTO M 240 with no additional restrictions. Limestone is classified as a processing addition to Porland cement, not as a supplementary cement. The use of other cements shall require approval of the Tollway materials department.
- Note 2: Fine and coarse aggregate requirements shall be per IDOT Class BS concrete
- Note 3: Supplementary cementitious materials must have an alkali content less than 3.5 percent (Na_2O_{eq}).
- Note 4: Shrinkage reducing admixtures (SRA) and slump retention admixtures from a Tollway approved source may be used.
- Note 5: Fiber reinforcement shall be permitted provided the material is used in accordance with the product manufacturer's recommendations and it is demonstrated that the concrete complies with the herein established performance requirements. Steel fibers shall conform to ASTM A820, Alkali-

resistant (AR) glass fibers shall conform to ASTM C1666 and synthetic fibers shall conform to ASTM D7508.

- Note 6: Saturated lightweight aggregate may be used in accordance with ASTM C1761.

MIXTURE QUALIFICATION REQUIREMENTS

Contractor shall provide a concrete mixture design according to the following performance requirements. The testing shall be performed by an AASHTO-accredited laboratory. Mixture designs not used in the current calendar year will require a current report of petrographic examination, performed in accordance with ASTM C856, using concrete produced from a trial batch witnessed by the Tollway in the current calendar year.

Slump Loss

Unless otherwise approved by the Tollway, the initial slump (measured within 10 minutes after the addition of water) shall be between 3 and 8 inches. The slump shall be no less than 3 inches for at least 45 minutes after the addition of water as measured by AASHTO T 119. The change in slump shall be no greater than 2 inches in 20 minutes and 4 inches from the initial measurement (measured within 10 minutes after the addition of water). The concrete temperature during testing shall be greater than 65°F.

Compressive Strength

Compressive strength measured in accordance with AASHTO T 22 shall not be less than 4,000 psi at 14 days. Test cylinders shall be made and cured in accordance with AASHTO T 23. The compressive strength determined in the laboratory shall be designated as f'_{target} for future acceptance of the mixture.

Time to Cracking

Net time to cracking shall not be less than 28 days when determined in accordance with ASTM C1581. Prior to batching for a test sample, all coarse aggregate particles exceeding ¾-inch shall be removed and replaced with an equal volume of minus ¾-inch graded material. This test shall be waived if the concrete mixture contains 605 lb/yd^3 or less total cementitious material and a minimum dosage of 1.5 gal/yd^3 of approved shrinkage reducing admixture (SRA).

Length Change

Measured shrinkage shall not be greater than 0.030 percent after 21 days of air drying when determined in accordance with AASHTO T 160. Specimens shall be wet cured for 7 days prior to air-drying. The initial reading for calculation of shrinkage shall be taken at the initiation of drying.

Freeze-Thaw Durability

Durability factor shall be no less than 80 percent after 300 cycles of freezing and thawing as determined in accordance with AASHTO T 161 (Procedure A) with the following

modifications: the 14-day curing period prior to freeze-thaw cycling shall consist of 7 days immersion, in saturated lime water at 73.4 ± 3.0 °F followed by 7 days of storage in air at 73.4 ± 2.0 °F and at a relative humidity of 50 ± 4.0 %.

The concrete will possess an air-void system having the following characteristics as determined by ASTM C457 (Method B):

- Spacing factor not exceeding 0.008-in.
- Specific surface not less than 600 in^2/in^3
- Total air content not less than 4.0 percent

The air-void system requirements will be waived if testing in accordance with AASHTO T 161 (Tollway-modified) results in a durability factor equal to or greater than 90 percent after 300 cycles of freezing and thawing.

Freeze-thaw testing in accordance with AASHTO T 161 (Tollway-modified) may be waived at the discretion of the Tollway if the air-void system parameters are met.

Chloride Penetrability

The total charge passed shall not exceed 1250 coulombs at 28 days as determined in accordance with AASHTO T 277 using the accelerated curing procedure. Test specimens shall be made in accordance with AASHTO T 23. Specimens shall be cured for one week at 73 ˚F and the following three weeks at 100 ˚F. An interim test result can be provided at the option of the contractor. A test shall consist of three specimens.

Alkali Silica Reactivity

Each aggregate shall be evaluated individually in accordance with AASHTO T 303 and must have a measured expansion no greater than 0.10 percent after 16 days. Each aggregate shall be evaluated separately. Each aggregate that does not meet this limit when tested with portland cement alone may demonstrate acceptance using a blended cement or a combination of portland cement and supplementary cementitious materials proposed for the HPC mixture. The supplementary cementitious replacement content needed to pass the AASHTO T 303 requirement shall become the minimum required replacement percentage of the concrete mixture.

This test shall be waived if the concrete is proportioned such that the maximum total alkali content (Na_2O_{eq}) contributed by portland cement (as determined in accordance with AASHTO T 105) does not exceed 4.0 lb/yd^3.

The test shall also be waived if the aggregate has been evaluated in accordance with ASTM C1293 within the last 12 months and has an average expansion of three concrete specimens equal to or less than 0.04 % at one year.

FIELD TRIAL BATCH ACCEPTANCE

Qualification of the concrete mixture will require a field trial batch in addition to laboratory testing. The field trial must be produced at the batch plant under the supervision of the Tollway materials department and must meet the following characteristics:

- Compressive strength measured in accordance with AASHTO T 22 at 14 days (f_c) shall be within $4000 \leq f_c \leq [f'_{target} + 1500]$ psi where f'_{target} is defined as the 14 day strength obtained in the laboratory qualification test.
- Unless otherwise approved by the Tollway, the slump shall be between 3 and 8 inches. The slump shall be no less than 3 inches for at least 45 minutes after the addition of water as measured by AASHTO T 119. The change in slump shall be no greater than 2 inches in 20 minutes and 4 inches from the initial measurement (taken within 10 minutes after the addition of water). The concrete temperature during testing shall be greater than 70°F.
- Plastic air content measured in accordance with AASHTO T 152 shall be ± 1.5 percent from the design. The plastic air content measured at the end of slump loss testing shall be greater than 4.0 percent.. A hardened air void analysis in accordance with ASTM C457 may be submitted as an alternative.
- Water / cementitious materials ratio – Design -0.03, +0.00
- The total charge passed shall not exceed 1500 coulombs at 28 days as determined in accordance with AASHTO T 277 using the accelerated curing procedure. Test specimens shall be made in accordance with AASHTO T 23. Specimens shall be cured for one week at 73 °F and the following three weeks at 100 °F. A test shall consist of three specimens.

MIXTURE QUALIFICATION SUBMITTAL

Submittal shall include:

1. Mixture design, showing:
    a. Quantities, description, sources and mill certifications of all mixture ingredients
    b. Design water-cementitious materials ratio (w/cm)
    c. Design Slump
    d. Design Air content
    e. Gradation and absorption of all aggregates
    f. Bulk specific gravity (SSD) of all cementitious materials and aggregates
    g. Theoretical mass and fresh density
    h. Admixture dosage
2. A mixture qualification report demonstrating that the concrete complies with the performance requirements herein specified.
3. Report of petrographic examination of trial batch concrete, performed in accordance with ASTM C856.
4. Report of chemical analysis by X-ray Fluorescence of trial batch concrete, performed in accordance with AASHTO T 105.

MATERIAL TOLERANCES

Portland Cement or Blended Cement

Once a mixture qualification has been approved, no re-submittal shall be required under the condition that the portland cement or blended cement source complies with the following tolerances:

- Alkali content (Na_2O_{eq}): ± 0.20 percent. The alkali silica reactivity requirements for the mixture qualification shall be met with the new alkali content.
- Tri-calcium aluminate content: -2.0 percent, +1.0 percent

Substitution of cement from sources not meeting the above tolerances shall only be permitted at the discretion of the Tollway materials department[1].

Coarse and Fine Aggregate

Substitution of aggregates from different sources or size classifications shall only be permitted at the discretion of the Tollway materials department[1]. Similar aggregate type and lithology are recommended to ensure that no change in constructability or performance occurs.

Supplementary Cementitious Materials

No change in grade, classification, or fly ash type shall be permitted without resubmittal unless approved by the Tollway materials department[1].

Concrete Admixtures and Other Materials

Contractor may change between ASTM C494 Type A and Type D admixtures as seasonal conditions warrant. No other changes in manufacturer or product shall be permitted without re-submittal unless approved by the Tollway materials department[1].

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[1] Changes other than those described herein may be permitted without re-submittal if approved by the Tollway materials department. A field trial batch may be required to demonstrate similarity and additional laboratory testing may be required to validate performance. Testing will be limited only to tests in this specification, and may consist only of selected tests depending on the substitution. The proposed substitution must be reviewed by the Tollway materials department to select the required tests for re-qualification. Some examples are:

• Mixtures using ASR susceptible aggregates shall require retesting to demonstrate ASR mitigation for any change to cementitious materials.
• Cementitious materials changes deemed to cause additional cracking risk, such as increases in fineness or reactivity shall require retesting restrained ring shrinkage, linear drying shrinkage, and slump loss.
• Changes to admixture products may require retesting for slump loss and hardened air-voids.

CURING AND PROTECTION

A proposed HPC mixture that complies with the specified properties defined herein shall be considered "fully optimal" if the mix contains no less than 6% (based on total weight) pre-wetted lightweight fines, contains a minimum of 35% (of total cement weight) supplementary cementing materials, shall contain a minimum dosage of 2.0 gal/yd^3 of approved shrinkage reducing admixture (SRA), and has a gradation that is well optimized with a minimum of 2 fine aggregates (natural sand and lightweights) and 2 coarse aggregates blended at the production plant to fall within the following gradation band.

AGGREGATE BLEND FOR THE "FULLY OPTIMAL" CLASS HPC MIX
Percent by weight passing

Sieve Size	% Passing
1 in.	**100**
¾ in.	**85-98**
½ in.	**65-85**
⅜ in.	**55-77**
# 4	**40-60**
# 8	**28-45**
# 16	**18-35**
# 30	**10-25**
# 50	**5-17**
#100	**1-12**
#200	**0-8**

Curing For Optimal HPC Mix Designs

Curing shall be in accordance with Article 1020.13(a)(5) of the standard specifications except as modified below.

Add the following paragraph to Article 1020.13(a)(5) of the standard specifications:

"The curing period for decks built with an approved "fully optimal" HPC mix design shall be no less than 4 days."

Curing For Other HPC Mix Designs

Curing shall be in accordance with Article 1020.13(a)(5) for a 7 day period.

For All HPC Mix Designs

Low air temperature protection methods shall be in accordance with Articles 1020.13(d)(1)(2) of the Standard Specifications except as modified below:

Replace the first sentence of Article 1020.13(d)(1) of the standard specifications with the following:

"When the official National Weather Service forecast for the construction area predicts a low below 45°F, or if the actual temperature drops below 45°F, concrete less than 72 hours old shall be provided protection. When protection is required, the temperature of water for curing shall be no less than 45°F."

The temperature of the curing water shall not be more than 20 °F cooler than the surface temperature of the concrete at the time the water and concrete come in contact. The curing water temperature shall be measured in the storage tank. The surface temperature of the concrete shall be measured under the cotton mats placed for curing. Measuring the temperatures of the curing water and concrete surface, and any required heating or cooling of the curing water, shall be the responsibility of the contractor. Water shall be potable, meet the requirements of ASTM C 94, and be free of materials that have the potential to stain concrete.

Use black or dark colored plastic sheets when the daily high ambient temperature is below 60 °F. Use white or similarly reflective plastic sheets when the daily high ambient temperature is above 85°F. Use any color or transparency of plastic sheet at temperatures between 60 and 85 °F.

TEMPERATURE CONTROL FOR PLACEMENT

Temperature control for concrete placement shall be according to Article 1020.14 of the standard specifications except as modified below:

Replace Article 1020.14(b) of the standard specifications with the following:

"Concrete in structures may be placed when the ambient air temperature is 40°F and rising, and concrete placement shall stop when the falling temperature reaches 45°F or below, unless otherwise approved by the Engineer. The temperature of the surfaces to receive concrete shall not be less than 40°F.

The temperature of the concrete at the point of placement shall not be less than 60°F for ternary mixtures or for any concrete with more than 20% fly ash or 35% slag replacement of Portland cement, and shall not be less than 45°F for all other mixtures, and shall not be more than 90°F for any mixture. The use of non-chloride accelerating admixture conforming to ASTM C494 Type C or E is allowed during cold weather placements when air temperatures below 45°F are anticipated before the expiration of the specified curing period, provided the accelerator is included in the original mixture qualification. When insulated forms are used, the maximum temperature of the concrete mixture shall be 80°F.

High performance concrete mixtures shall not be placed when the ambient air temperature exceeds 90ºF without approval of the Engineer. The maximum concrete temperature shall be 85ºF for the cast-in-place high performance concrete mixtures at the point of placement, except when placement operations are conducted at night, when the maximum concrete temperature shall be 90ºF. The difference in temperature of the forms and concrete shall be <10ºF at time of placement."

QUALITY MANAGEMENT PLAN

At least 14 days prior to the first concrete placement, the Contractor shall submit a Quality Management Plan (QMP), for materials and construction in accordance with the Illinois Tollway recurring Special Provision for Contractor's Quality Program Minimum job-site testing procedures shall be per the IDOT QC/QA Special Provision. Contractor personnel performing testing shall be IDOT certified Level I PCC Technician or higher.

PRODUCTION FACILITY AND TRANSPORTATION EQUIPMENT

The production facility and transportation equipment shall conform to the certification requirements of the Illinois Department of Transportation.

FIELD ACCEPTANCE

Acceptance to this specification shall be based on the following characteristics:

- Compressive strength measured in accordance with AASHTO T 22 at 14 days (f_c) shall be within $4000 \leq f_c \leq [f'_{target} +1500]$ psi where f'_{target} is defined as the 14 day strength obtained in the laboratory qualification test.
- Unless otherwise approved by the Tollway, the slump shall be between 3 and 8 inches when delivered to the project site.
- Plastic air content measured in accordance with AASHTO T 152 shall be ± 1.5 percent from the design, with a minimum of 4.0 percent. A hardened air void analysis in accordance with ASTM C457 may be submitted as an alternative.
- Water / cementitious materials ratio – Design -0.03, +0.00

Other quality assurance testing required by the Tollway, but not included as a basis for payment shall consist of:

- The total charge passed shall not exceed 1500 coulombs at 28 days as determined in accordance with AASHTO T 277 using the accelerated curing procedure. Test specimens shall be made in accordance with AASHTO T 23 at the same frequency as compressive strength testing. A minimum of two tests shall be required for each bridge deck placement where each test consists of three specimens. Specimens shall be cured for one week at 73 ˚F and the following three weeks at 100 ˚F.
- A petrographic examination in accordance with ASTM C856 and chemical analysis according to AASHTO T 105 may be used at the discretion of the Tollway to screen for changes in composition.

STRUCTURAL REPAIR OF CONCRETE (Tollway GBSP)

Effective: May 29, 2007
Revised: November 19, 2012

Description. This work shall consist of structurally repairing concrete.

Materials. Materials shall be according to the following.

Item	Article/Section
(a) Portland Cement Concrete (Note 1)	1020
(b) R1 or R2 Mortar (Note2)	
(c) Normal Weight Concrete (Note 3)	
(d) Shotcrete (High Performance) (Note 4)	
(e) Reinforcement Bars	1006.10
(f) Anchor Bolts	1006.09
(g) Water	1002
(h) Curing Compound (Type I)	1022.01
(i) Cotton Mats	1022.02
(j) Protective Coat	1023.01
(k) Epoxy (Note 5)	1025
(l) Mechanical Bar Splicers	508.06(c)

Note 1. The concrete shall be Class SI, except the cement factor shall be a minimum 6.65 cwt/cu. yd., the coarse aggregate shall be a CA 16, and the strength shall be a minimum 4000 psi compressive or 675 psi flexural at 14 days. A high range water-reducing admixture shall be used to obtain a 5-7 in. slump, but the cement factor shall not be reduced. This cement factor restriction shall also apply if a water-reducing admixture is used.

Note 2. The R1 or R2 Mortar shall be from the Department's approved list of Packaged, Dry,Rapid Hardening, Cementitious Materials for Concrete Repairs with coarse aggregate added. The amount of coarse aggregate added to the R1 or R2 Mortar shall be per the manufacturer's recommendations. The coarse aggregate gradation shall be CA 16 from an Aggregate Gradation Control System source or a packaged aggregate meeting Article 1004.02 with a maximum size of 1/2 in.. The R1 or R2 Mortar and coarse aggregate mixture shall comply with the air content and strength requirements for Class SI concrete as indicated in Note 1. Mixing shall be per the manufacturer's recommendations, except the water/cement ratio shall not exceed the value specified for Class SI concrete as indicated in Note 1. A high range water-reducing admixture shall be used to obtain a 5-7 in. slump.

Note 3. The packaged concrete mixture shall be from the Department's approved list of Packaged, Dry, Formed, Concrete Repair Mixtures. The materials and preparation of aggregate shall be according to ASTM C 387. Proportioning shall be according to ASTM C 387, except the minimum cement factor shall be 6.65 cwt/cu.yd.. Cement replacement with fly ash or ground granulated blast-furnace slag shall be according to Section 1020. The coarse aggregate shall be a maximum size of 1/2 in.. The packaged concrete mixture shall comply with the air content and strength requirements for Class SI concrete as indicated in Note 1. Mixing shall be per the manufacturer's recommendations, except the water/cement ratio shall not exceed

the value specified for Class SI concrete as indicated in Note 1. A high range water-reducing admixture shall be used to obtain a 5-7 in. slump.

Note 4. A packaged, pre-blended, and dry combination of materials, for the wet-mix shotcrete method shall be provided according to ASTM C 1480. An accelerator is prohibited, except the shotcrete may be modified at the nozzle with a non-chloride accelerator for overhead applications. The shotcrete shall be Type FA, Grade FR, and Class I. The fibers shall be Type III synthetic according to ASTM C 1116.

The packaged shotcrete shall have a maximum water soluble chloride ion content of 0.06 % by weight (mass) of cement. The test shall be performed according to ASTM C 1218, and the hardened shotcrete shall have an age of 28 to 42 days at the time of test. The test shall be performed a minimum of once every two years.

Each individual aggregate used in the packaged shotcrete shall have either a maximum ASTM C 1260 expansion of 0.16 percent or a maximum ASTM C 1293 expansion of 0.040 percent. However, the ASTM C 1260 value may be increased to 0.27 percent for each individual aggregate if the cement total equivalent alkali content ($Na_2O + 0.658K_2O$) does not exceed 0.60 percent. As an alternative to these requirements, ASTM C 1567 testing which shows the packaged shotcrete has a maximum expansion of 0.16 percent may be submitted. The ASTM C 1260, C 1293, or C 1567 test shall be performed a minimum of once every two years.

The 7 and 28 day compressive strength requirements in ASTM C 1480 shall not apply. Instead the shotcrete shall obtain a minimum compressive strength of 4000 psi at 14 days.

The packaged shotcrete shall be limited to the following proportions:

The portland cement and finely divided minerals shall be 6.05 cwt/cu. yd. to 8.50 cwt/cu. yd for Type FA and 6.05 cwt/cu. yd. to 7.50 cwt/cu. yd. for Type CA. The portland cement shall not be below 4.70 cwt/cu. yd. for Type FA or CA.
The finely divided mineral(s) shall constitute a maximum of 35 percent of the total cement plus finely divided mineral(s).

Class F fly ash is optional and the maximum shall be 20 percent by weight of cement.

Class C fly ash is optional and the maximum shall be 25 percent by weight of cement.

Ground granulated blast-furnace slag is optional and the maximum shall be 30 percent by weight of cement.

Microsilica is required and shall be a minimum of 5 percent by weight of cement, and a maximum of 10 percent. As an alternative to microsilica, high-reactivity metakaolin may be used at a minimum of 5 percent by weight of cement, and a maximum of 10 percent.

Fly ash shall not be used in combination with ground granulated blast-furnace slag. Class F fly ash shall not be used in combination with Class C fly ash. Microsilica shall not be used in combination with high-reactivity metakaolin. A finely divided mineral shall not be used in combination with a blended hydraulic cement, except for microsilica or high-reactivity metakaolin.

The water/cement ratio as defined in Article 1020.06 shall be a maximum of 0.42.

The air content as shot shall be 4.0 – 8.0 percent.

Note 5. In addition ASTM C 881, Type IV, Grade 2 or 3, Class A, B, or C may be used.

Equipment. Equipment shall be according to Article 503.03 and the following.

Chipping Hammer – The chipping hammer for removing concrete shall be a light-duty pneumatic or electric tool with a 15 lb. maximum class or less.

Blast Cleaning Equipment – Blast cleaning equipment for concrete surface preparation shall be the abrasive type, and the equipment shall have oil traps.

Hydrodemolition Equipment – Hydrodemolition equipment for removing concrete shall be calibrated, and shall use water according to Section 1002.

High Performance Shotcrete Equipment – The batching, mixing, pumping, hose, nozzle, and auxiliary equipment shall be for the wet-mix shotcrete method, and shall meet the requirements of ACI 506R.

Construction Requirements

General. The repair methods shall be either formed concrete repair or shotcrete. The repair method shall be selected by the Contractor with the following rules.

(a) Rule 1. For formed concrete repair, a subsequent patch to repair the placement point after initial concrete placement will not be allowed. As an example, this may occur in a vertical location located at the top of the repair.

(b) Rule 2. Formed concrete repair shall not be used for overhead applications.

(c) Rule 3. Shotcrete shall not be used for column repairs greater than 4 in. in depth, or any repair location greater than 8 in. in depth. The only exception to this rule would be for a horizontal application, where the shotcrete may be placed from above in one lift.

(d) Rule 4. If formed concrete repair is used for locations that have reinforcement with less than 0.75 in. of concrete cover, the concrete mixture shall contain fly ash or ground granulated blast-furnace slag at the maximum cement replacement allowed.

Temporary Shoring or Cribbing. When a temporary shoring or cribbing support system is required, the Contractor shall provide details and computations, prepared and sealed by an Illinois licensed Structural Engineer, to the Engineer for review and approval. When ever possible the support system shall be installed prior to starting the associated concrete removal. If no system is specified, but during the course of removal the need for temporary shoring or cribbing becomes apparent or is directed by the Engineer due to a structural concern, the Contractor shall not proceed with any further removal work until an appropriate and approved support system is installed.

Concrete Removal. The Contractor shall provide ladders or other appropriate equipment for the Engineer to mark the removal areas. Repair configurations will be kept simple, and squared corners will be preferred. The repair perimeter shall be sawed a depth of 1/2 in. or less, as required to avoid cutting the reinforcement. Any cut reinforcement shall be repaired or replaced at the expense of the Contractor. If the concrete is broken or removed beyond the limits of the initial saw cut, the new repair perimeter shall be recut. The areas to be repaired shall have all loose, unsound concrete removed completely by the use of chipping hammers, hydrodemolition equipment, or other methods approved by the Engineer. The concrete removal shall extend along the reinforcement bar until the reinforcement is free of bond inhibiting corrosion. The outermost layer of reinforcement bar within the repair area shall be undercut to a depth of 3/4 in. (19 mm) or the diameter of the reinforcement bar, whichever value is larger. The underlying transverse reinforcement bar shall also be undercut as previously described, unless the reinforcement is not corroded, and the reinforcement bar is encased and well bonded to the surrounding concrete.

If sound concrete is encountered before existing reinforcement bars are exposed, further removal of concrete shall not be performed unless the minimum repair depth is not met.

The repair depth shall be a minimum of 1 in.. The substrate profile shall be ± 1/16 in. . The perimeter of the repair area shall have a vertical face.

If a repair is located at the ground line, any excavation required below the ground line to complete the repair shall be included in this work.

The Contractor shall have a maximum of 14 calendar days to complete each repair location with concrete or shotcrete, once concrete removal has started for the repair.

The Engineer shall be notified of concrete removal that exceeds 6 in. in depth, one fourth the cross section of a structural member, more than half the vertical column reinforcement is exposed in a cross section, more than 6 consecutive reinforcement bars are exposed in any direction, within 1.5 in. of a bearing area, or other structural concern. Excessive deterioration or removal may require further evaluation of the structure or installation of temporary shoring and cribbing support system.

Surface Preparation. Prior to placing the concrete or shotcrete, the Contractor shall prepare the repair area and exposed reinforcement by blast cleaning. The blast cleaning shall provide a surface that is free of oil, dirt, and loose material.

If a succeeding layer of shotcrete is to be applied, the initial shotcrete surface and remaining exposed reinforcement shall be free of curing compound (Where applied on overhead surfaces only), oil, dirt, loose material, rebound (i.e. shotcrete material leaner than the original mixture which ricochets off the receiving surface), and overspray. Preparation may be by lightly brushing

or blast cleaning if the previous shotcrete surface is less than 36 hours old. If more than 36 hours old, the surface shall be prepared by blast cleaning.

The repair area and perimeter vertical face shall have a rough surface. Care shall be taken to ensure the perimeter sawcut is roughened. Just prior to concrete or shotcrete placement, saturate the repair area with water to a saturated surface-dry condition. Any standing water shall be removed.

Concrete or shotcrete placement shall be done within 3 calendar days of the surface preparation or the repair area shall be prepared again.

Reinforcement. Exposed reinforcement bars shall be cleaned of concrete and corrosion by blast cleaning. After cleaning, all exposed reinforcement shall be carefully evaluated to determine if replacement or additional reinforcement bars are required.

Reinforcing bars that have been cut or have lost 25 percent or more of their original cross sectional area shall be supplemented by new in kind reinforcement bars. New bars shall be lapped a minimum of 32 bar diameters to existing bars. A mechanical bar splicer shall be used when it is not feasible to provide the minimum bar lap. No welding of bars shall be performed.

Intersecting reinforcement bars shall be tightly secured to each other using 0.06 in. or heavier gauge tie wire, and shall be adequately supported to minimize movement during concrete placement or application of shotcrete.

For reinforcement bar locations with less than 0.75 in. of cover, protective coat shall be applied to the completed repair. The application of the protective coat shall be according to Article 503.19, 2nd paragraph, except blast cleaning shall be performed to remove curing compound (where applied on overhead surfaces) on the finished surface.

The Contractor shall anchor the new concrete to the existing concrete with 3/4 in. diameter hook bolts for all repair areas where the depth of concrete removal is greater than 8 in. and there is no existing reinforcement extending into the repair area. The hook bolts shall be spaced at 15-inch maximum centers both vertically and horizontally, and shall be a minimum of 12 inches away from the perimeter of the repair. The hook bolts shall be installed according to Section 584.

Repair Methods. All repair areas shall be inspected and approved by the Engineer prior to placement of the concrete or application of the shotcrete.

(a) Formed Concrete Repair. Falsework shall be according to Article 503.05. Forms shall be according to Article 503.06. Formwork shall provide a smooth and uniform concrete finish, and shall approximately match the existing concrete structure. Formwork shall be mortar tight and closely fitted where they adjoin the existing concrete surface to prevent leakage. Air vents may be provided to reduce voids and improve surface appearance. The Contractor may use exterior mechanical vibration, as approved by the Engineer, to release air pockets that may be entrapped.

The concrete for formed concrete repair shall be a Class SI Concrete or a packaged R1or R2 Mortar with coarse aggregate added, or a packaged Normal Weight Concrete at the Contractor’s option. The concrete shall be placed and consolidated according to Article 503.07. The concrete shall not be placed when frost is present on the surface of

the repair area, or the surface temperature of the repair area is less than 40 °F. All repaired members shall be restored as close as practicable to their original dimensions.

Curing shall be done according to Article 1020.13.

If temperatures below 45°F are forecast during the curing period, protection methods shall be used. Protection Method I according to Article 1020.13(d)(1), or Protection Method II according to Article 1020.13(d)(2) shall be used during the curing period.

The surfaces of the completed repair shall be finished according to Article 503.15.

(b) Shotcrete. Shotcrete shall be tested by the Engineer for air content according to Illinois Modified AASHTO T 152. Obtain the sample in a damp, non-absorbent container from the discharge end of the nozzle.

For compressive strength of shotcrete, a 18 x 18 x 3.5 in. test panel shall be shot by the Contractor for testing by the Engineer. A steel form test panel shall have a minimum thickness of 3/16 in. for the bottom and sides. A wood form test panel shall have a minimum 3/4 in. thick bottom, and a minimum 1.5 in. thickness for the sides. The test panel shall be cured according to Article 1020.13 (a) (3) or (5) while stored at the jobsite and during delivery to the laboratory. After delivery to the laboratory for testing, curing and testing shall be according to ASTM C 1140.

The method of alignment control (i.e. ground wires, guide strips, depth gages, depth probes, and formwork) to ensure the specified shotcrete thickness and reinforcing bar cover is obtained shall be according to ACI 506R. Ground wires shall be removed after completion of cutting operations. Guide strips and formwork shall be of dimensions and a configuration that do not prevent proper application of shotcrete. Metal depth gauges shall be cut 1/4 in. below the finished surface. All repaired members shall be restored as close as practicable to their original dimensions.

For air temperature limits when applying shotcrete in cold weather, the first paragraph of Article 1020.14(b) shall apply. For hot weather, shotcrete shall not be applied when the air temperature is greater than 90°F. The applied shotcrete shall have a minimum temperature of 50°F and a maximum temperature of 90°F. The shotcrete shall not be applied during periods of rain unless protective covers or enclosures are installed. The shotcrete shall not be applied when frost is present on the surface of the repair area, or the surface temperature of the repair area is less than 40°F. If necessary, lighting shall be provided to provide a clear view of the shooting area.

The shotcrete shall be applied according to ACI 506R, and shall be done in a manner that does not result in cold joints, laminations, sandy areas, voids, sags, or separations. In addition, the shotcrete shall be applied in a manner that results in maximum densification of the shotcrete. Shotcrete which is identified as being unacceptable while still plastic shall be removed and re-applied.

The nozzle shall normally be at a distance of 2 to 5 ft. from the receiving surface, and shall be oriented at right angles to the receiving surface. Exceptions to this requirement will be permitted to fill corners, encase large diameter reinforcing bars, or as approved by the Engineer. For any exception, the nozzle shall never be oriented more than 45 degrees from the surface. Care shall be taken to keep the front face of the reinforcement

bar clean during shooting operations. Shotcrete shall be built up from behind the reinforcement bar. Accumulations of rebound and overspray shall be continuously removed prior to application of new shotcrete. Rebound material shall not be incorporated in the work.

Whenever possible, shotcrete shall be applied to the full thickness in a single layer. The maximum thickness shall be 4 in. unless the shotcrete is applied from above on a horizontal surface, or a thicker application is approved by the Engineer. When two or more layers of exposed vertical reinforcement exist, multiple layers of shotcrete shall be applied. The first layer of reinforcement shall be encased before shooting begins to encase the next layer. When two or more layers are required, the minimum number shall be used and shall be done in a manner without sagging or separation. A flash coat (i.e. a thin layer of up to 1/4 in. applied shotcrete) may be used as the final lift for overhead applications.

Prior to application of a succeeding layer of shotcrete, the initial layer of shotcrete shall be prepared according to the surface preparation and reinforcement bar cleaning requirements. Upon completion of the surface preparation and reinforcement bar treatment, water shall be applied according to the surface preparation requirements unless the surface is moist. The second layer of shotcrete shall then be applied within 30 minutes.

Shotcrete shall be cut back to line and grade using trowels, cutting rods, screeds or other suitable devices. The shotcrete shall be allowed to stiffen sufficiently before cutting. Cutting shall not cause cracks or delaminations in the shotcrete. For depressions, cut material may be used for small areas. Rebound material shall not be incorporated in the work. For the final finish, a wood float shall be used to approximately match the existing concrete texture. All repaired members shall be restored as close as practicable to their original dimensions.

Contractor operations for curing shall be continuous with shotcrete placement and finishing operations. The Engineer may require modification of operations to ensure satisfactory results are obtained. Cotton mats shall be applied according to Article 1020.13(a)(5) except the exposed layer of shotcrete shall be covered within 10 minutes after finishing, and continuous wet curing shall begin immediately. As an alternative to this method,Type I curing compound shall be applied according to Article 1020.13(a)(4) within 10 minutes and moist curing with cotton mats shall begin within 3 hours. For overhead applications where the final shotcrete layer has been applied, the Contractor has the option to use Type I curing compound in lieu of the cotton mats. Note 5 of the Index Table in Article 1020.13 shall apply to the membrane curing method. The curing compound shall be applied according to Article 1020.13(a)(4).

When a shotcrete layer is to be covered by a succeeding shotcrete layer within 36 hours, the repair area shall be protected with intermittent hand fogging, or continuous wet curing with either burlap or cotton mats shall begin within 10 minutes. Intermittent hand fogging may be used only for the first hour. Thereafter, continuous wet curing with burlap or cotton mats shall be used until the succeeding shotcrete layer is applied. Intermittent hand fogging may be extended to the first hour and a half if the succeeding shotcrete layer is applied by the end of this time.

The curing period shall be for 7 days, except when there is a succeeding layer of shotcrete. In this instance, the initial shotcrete layer shall be cured until the surface preparation and reinforcement bar treatment is started.

If temperatures below 45°F are forecast during the curing period, protection methods shall be used. Protection Method I according to Article 1020.13(d)(1), or Protection Method II according to Article 1020.13(d)(2) shall be used during the curing period.

Inspection of Completed Work. The Contractor shall provide ladders or other appropriate equipment for the Engineer to inspect the repaired areas. After curing but no sooner than 28 days after placement of concrete or shooting of shotcrete, the repair shall be examined for conformance with original dimensions, cracks, voids, and delaminations. Sounding for delaminations will be done with a hammer or by other methods determined by the Engineer.

The repaired area shall be removed and replaced, as determined by the Engineer, for nonconformance with original dimensions, surface cracks greater than 0.01 in. in width, map cracking with a crack spacing in any direction of 18 in. or less, voids, or delaminations.

If a nonconforming repair is allowed to remain in place, cracks 0.01 in. or less shall be repaired with epoxy according to Section 590. For cracks less than 0.007 in., the epoxy may be applied to the surface of the crack. Voids shall be repaired according to Article 503.15.

Publications and Personnel Requirements. The Contractor shall provide a current copy of ACI 506R to the Engineer a minimum of one week prior to start of construction.

The shotcrete personnel who perform the work shall have current American Concrete Institute (ACI) nozzlemen certification for vertical wet and overhead wet applications, except one individual may be in training. This individual shall be adequately supervised by a certified ACI nozzlemen as determined by the Engineer. A copy of the nozzlemen certificate(s) shall be given to the Engineer.

Method of Measurement. This work will be measured for payment in place and the area computed in square feet. For a repair at a corner, both sides will be measured.

Basis of Payment. This work will be paid for at the contract unit price per square foot for STRUCTURAL REPAIR OF CONCRETE (DEPTH GREATER THAN 5 IN.), STRUCTURAL REPAIR OF CONCRETE (DEPTH EQUAL TO OR LESS THAN 5 IN.).

When not specified to be paid for elsewhere, the work to design, install, and remove the temporary shoring and cribbing will be paid for according to Article 109.04 of the Tollway Supplemental specifications.

With the exception of reinforcement damaged by the Contractor during removal, the furnishing and installation of supplemental reinforcement bars, mechanical bar splicers, hook bolts, and protective coat will be paid according to Article 109.04 of the Tollway Supplemental specifications.

Pay Item Number	Designation	Unit of Measure
JT503041	STRUCTURAL REPAIR OF CONCRETE (DEPTH GREATER THAN 5 IN)	SQ FT
JT503040	STRUCTURAL REPAIR OF CONCRETE (DEPTH EQUAL TO OR LESS THAN 5 IN)	SQ FT

#30

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, April 08, 2016 12:06:27 PM
Last Modified: Friday, April 08, 2016 1:42:18 PM
Time Spent: 01:35:51
IP Address: 108.59.48.4

PAGE 1

Q1: **State Representative**

Name	Anthony Zander
Agency	INDOT
State / Province	IN
Email	azander@indot.in.gov

Q2: **Do you a high performance bridge deck mix specification?**

If yes, what are the mix design requirements?
Mix is being developed under Experimental Feature Study for Internal Cure High Performance Concrete (IC-HPC). Currently the INDOT mix design requirements are: 1) paste volume shall not exceed 26.0 % of concrete volume 2) Ternary binder system must be used. Design cement content shall be at least 390 lbs. 3) Class C or F fly ash shall be used as part of ternary binder system and shall constitute 20.0 to 25.0% of total cementitious, by weight. Ground granulated blast furnace slag may be used in lieu of fly ash and shall constitute 15.0 to 30.0% of total cementious, by weight. 4) Silica fume shall constitute 3.0 to 7.0% of the total cementitious, by weight 5) Water/Cementitious ratio of delivered concrete shall be within +/- 0.025 of target and shall not exceed 0.430 nor be less than 0.360. 6) Target air content of 6.5% 7) Total fine aggregate volume shall be no less than 35% nor more than 45% of the total aggregate volume. Lightweight fine aggregate shall be used for internal curing. The dry weight of Lwt FA is determined by multiplying the cementitious content by 0.072 and dividing by the laboratory absorption as measured by ITM 222. Volume of Lwt FA in lab absorption condition is determined using specific gravity factor as measure by ITM 222. Volume of Lwt FA need for IC replaces same volume of natural sand in mix without IC. Volume of Lwt FA shall not be less than 30% of total volume of fine aggregate. 8) Target 28-day compressive strength is 5000 psi minimum. 9) Target Resistance to Chloride Ion Penetration is 1500 C maximum at 56-days

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?	Yes, If yes, what types? What percentage? Please be as specific as you can. For conventional bridge deck concrete (i.e. non high perfromance) the cement content is set at 658 pcy. Fly ash can replace cement by up to 20%, by weight; however, the replacement ratio for fly ash is 1.25 to 1. Ground granulated blast furnace slag can replace cement by up to 30%, by weight, at a 1:1 replacement ratio.
Q4: Have you used fibers in bridge deck mixes?	No
Q5: Have you used shrinkage reducing admixtures in bridge decks?	No
Q6: Have you used lightweight aggregate in bridge deck mixes?	If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can. Lightweight fine aggregate is use for internal curing in high performance mixes. The proportioning is described in Question 2.

Q7: What are your curing requirements for bridge decks?

Wet curing for a minimum of 168 hours.

Q8: Do you have smoothness requirements for bridge decks?	No
Q9: Do you typically grind bridge decks?	No
Q10: Do you seal bridge decks?	Yes

Q11: What type of sealers do you allow/specify?

Silane	Allow
Siloxane	Allow
Other	Allow
Additional Comments?	For decks built with conventional concrete, epoxy penetrating sealers are used, and may be more typical than Silane or Siloxane penetration sealers because of the 28-day requirement for curing concrete before application. Epoxy penetrating sealers only require 72 hour dry cure prior to application. If a deck is built with IC-HPC, it is not surface sealed. Use of epoxy chip seal is limited to bridge deck preservation and is typically not done on new construction. Latex Modified Concrete overlay is rarely used in new deck construction and limited to rehabilitation of existing bridge decks.

Q12: What is the application rate for each sealer?

Silane	Allow
Siloxane	Allow
Other	Allow
Additional Comments?	For the non-epoxy (silane siloxane) the application rate is 90-100 sq ft per gallon. For epoxy penetrating sealers, the application rate is 90-110 sq ft per gallon

Q13: What is the typical performance life of a sealed joint?

Decks without expansion joints is preferred. INDOT utilizes integral end bent design for new bridges, or new superstructure. Older bridges may be re-designed as semi-integral when the deck is replaced.

Q14: If you seal bridge decks, how often do you retreat?	If Yes, what is it? Does your Agency retreat or do you let a Contract for the work? INDOT is just starting to pursue this as part of preventative maintenance.

Q15: Please attach a link to approved products list and approval process for joint sealants.

Structural Expansion Joints is covered by Section 724 of INDOT Standard Specifications.

http://www.in.gov/dot/div/contracts/standards/book/sep15/7-2016.pdf

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.	If Yes, what is it? The INDOT specification for pneumatically placed mortar is out dated. See Section 708 of INDOT Standard Specification. http://www.in.gov/dot/div/contracts/standards/book/sep15/7-2016.pdf
Q17: Any additional comments?	*Respondent skipped this question*

#5

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, March 15, 2016 1:29:39 PM
Last Modified: Tuesday, March 15, 2016 2:02:07 PM
Time Spent: 00:32:28
IP Address: 165.206.209.230

PAGE 1

Q1: **State Representative**

Name	Todd Hanson
Agency	Iowa DOT
State / Province	Iowa
Email	todd.hanson@dot.iowa.gov

Q2: **Do you a high performance bridge deck mix specification?**

If yes, what are the mix design requirements?
- Maximum water to cementitious ratio of 0.45 for substructure and 0.42 for deck - Target -Maximum 28 day permeability of 2000 coulombs for the substructure (or greater than 20 K ohm-cm surface resistivity by Wenner probe) and 1500 coulombs for the deck (or greater than 30 K ohm-cm surface resistivity by Wenner probe). -Design Strength 4000 psi. Some elements are 5000 psi minimum 28 day compressive strength -Coarse aggregate meeting Class 3i durability

Q3: **Do you allow supplementary cementitious materials in bridge deck mixes?**

Yes,

If yes, what types? What percentage? Please be as specific as you can.
• Type IP or IS cement or a Type I/II cement with a minimum of 25% weight (mass) replacement with GGBFS. • Use fly ash with maximum fly ash replacement not to exceed 20% by weight of the cement. • Maximum total replacement of 50% by weight (mass) of the cement.

Q4: **Have you used fibers in bridge deck mixes?**

It depends

Q5: **Have you used shrinkage reducing admixtures in bridge decks?**

No

Q6: **Have you used lightweight aggregate in bridge deck mixes?**

No

Q7: **What are your curing requirements for bridge decks?**

Apply water to the burlap covering for 168 hours of continuous wet sprinkling system curing

Q8: **Do you have smoothness requirements for bridge decks?**	If yes, what criteria do you use and how is it measured. Ames or California profilograph currently. Switching to IRI in the next couple years. Limits for average profile index per 0.1 mile are as follows: New Bridge Deck less than 22.1 inches/mile Bridge Deck Overlay less than 15.1 inches/mile Bridge Approach (New or Overlaid) less than 22.1 inches/mile
Q9: **Do you typically grind bridge decks?**	For what reason? Smoothness, Noise, Other? Grind for smoothness only. All decks are grooved. Transverse grooving or tining in plastic concrete of bridge decks (and bridge approaches when included in the bridge project) will not be allowed unless otherwise stated in the contract documents. 2) Cut longitudinal grooves into hardened concrete surfaces using a mechanical cutting device. Perform longitudinal grooving after surface correction grinding. 3) Ensure longitudinal grooves are: a) 1/8 inch ± 1/64 inch wide, b) 1/8 inch to 1/4 inch deep, and c) Uniformly spaced at 3/4 inch intervals measured center to center of groove.
Q10: **Do you seal bridge decks?**	No
Q11: What type of sealers do you allow/specify?	*Respondent skipped this question*
Q12: What is the application rate for each sealer?	*Respondent skipped this question*
Q13: What is the typical performance life of a sealed joint?	*Respondent skipped this question*
Q14: **If you seal bridge decks, how often do you retreat?**	No
Q15: Please attach a link to approved products list and approval process for joint sealants.	*Respondent skipped this question*
Q16: **Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.**	If Yes, what is it? SP-090080
Q17: Any additional comments?	*Respondent skipped this question*

#22

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, April 04, 2016 4:02:10 PM
Last Modified: Monday, April 04, 2016 4:19:46 PM
Time Spent: 00:17:36
IP Address: 165.201.162.178

PAGE 1

Q1: **State Representative**

Name	Dave Meggers
Agency	Kansas DOT
State / Province	Kansas
Email	dave.meggers@ksdot.org

Q2: **Do you a high performance bridge deck mix specification?**

No

Q3: **Do you allow supplementary cementitious materials in bridge deck mixes?**

Yes,

If yes, what types? What percentage? Please be as specific as you can.
All Concrete other than On Grade Concrete. Type I Portland Cement Type IP(x) Portland-Pozzolan Cement Type IS(x) Portland- Slag Cement Type IT(Ax)(By) Ternary Blended Cement Type II Portland Cement TABLE 401-2: ALLOWABLE SUBSTITUTION RATE FOR SUPPLEMENTARY CEMENTITIOUS MATERIAL. Material Substitution Rate* Slag Cement 40% Maximum Fly Ash 25% Maximum Blended SCM 25% Maximum Silica Fume 5% Max Total Combined 50% * Total Substitution Rate includes material in preblended cements and blended SCMs.

Q4: **Have you used fibers in bridge deck mixes?**

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
MIcro Fibers at 3 lbs per cubic yard. Macro Fibers at manufacturer recomendations.

Q5: **Have you used shrinkage reducing admixtures in bridge decks?**

No

Q6: **Have you used lightweight aggregate in bridge deck mixes?**

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
To present it was to rehabilitate two county bridges to reduce the dead load and allow for a slight widening and increase in allowable live load. Mixes were both roughly 50% sand with 50% lightweight aggregate.

Q7: What are your curing requirements for bridge decks?

14 day wet cure then application of white pigmented curing compound for 7 days

Q8: Do you have smoothness requirements for bridge decks?	If yes, what criteria do you use and how is it measured. Secure a smooth riding bridge deck, correcting surface variations exceeding ⅛ inch in 10 feet by use of an approved profiling device, or other method approved by the Engineer.
Q9: Do you typically grind bridge decks?	For what reason? Smoothness, Noise, Other? On most of KDOT's mainline structures the tining is ground in to allow for better curing procedures. Local bridges are not typically ground unless there is a problem with the surface.
Q10: Do you seal bridge decks?	Additional Comments Only if for some reason we have a problem during construction which results in excessive cracking.

Q11: What type of sealers do you allow/specify?

Silane	Do not use
Siloxane	Do not use
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Additional Comments?	Typically sealers are used only if there is a problem. Multi-layer polymer overlays have been a maintanance repair for many years on existing structures. They are now being used on new structures.

Q12: What is the application rate for each sealer?

Silane	Do not use
Siloxane	Do not use
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Additional Comments?	MMA or Epoxy are flood coated to refusal and sanded.

Q13: What is the typical performance life of a sealed joint?	*Respondent skipped this question*
Q14: If you seal bridge decks, how often do you retreat?	No
Q15: Please attach a link to approved products list and approval process for joint sealants.	*Respondent skipped this question*
Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.	If Yes, what is it? Very minimal at this time, working on improving.

#10

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, March 18, 2016 7:54:16 AM
Last Modified: Friday, March 18, 2016 8:00:32 AM
Time Spent: 00:06:15
IP Address: 130.39.255.10

PAGE 1

Q1: **State Representative**

Name	Tyson Rupnow
Agency	LADOTD
State / Province	LA
Email	Tyson.Rupnow@la.gov

Q2: **Do you a high performance bridge deck mix specification?**

If yes, what are the mix design requirements?
All structural concrete placed in LA is considered HPC at this time since the inclusion of SR testing. Mixtures vary widely. We also have no minimum cementitious content.

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
901.08.2 Cementitious Material Substitution For structural classes of concrete, fly ash conforming to 1001.04 and GGBFS conforming to 1001.05 may be partially substituted for portland cement on a pound for pound basis. For purposes of cement material substitution with fly ash and slag, do not treat Type IL cement as blended. A binary concrete mix is one that combines portland cement and one additional cementitious replacement, e.g., GGBFS or fly ash (class C or F). A ternary concrete mix is one that combines portland cement with two additional cementitious replacements, e.g., GGBFS and fly ash (class C or F) or fly ash (both class C and F). The maximum substitution rate for binary mixtures is 30 percent fly ash or 50 percent GGBFS. The maximum substitution rate for ternary mixtures containing Type I, II, III, or 1L portland cement is 70 percent of cement. When using Type IP or IS portland cement, the maximum substitution rate for ternary mixtures is 40 percent. Ternary combinations using both class C and F fly ash are allowable. When using fly ash ternary mixtures, replace portland cement with class C and class F fly ash in equal amounts. When using combinations of GGBFS and fly ash, the amount of GGBFS must be equal to or greater than the amount of fly ash. For pavement types of concrete (Types B and D), the maximum substitution rate for ternary mixtures is limited to 50 percent of cement and for binary mixtures is 30 percent fly ash or 50 percent GGBFS.

Q4: Have you used fibers in bridge deck mixes?

It depends,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
We have used them for thin overlays.

Q5: Have you used shrinkage reducing admixtures in bridge decks?

No

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
We have used lightweight fines for internal curing purposes. We have also used lightweight coarse to reduce dead load in the past. Lightweight fines are used in the 150-300 PCY replacement of fine aggregate range. Lightweight coarse was used in the 80-90 percent replacement of the coarse fraction in the past.

Q7: What are your curing requirements for bridge decks?

10-day wet cure

Q8: **Do you have smoothness requirements for bridge decks?**	No
Q9: **Do you typically grind bridge decks?**	No
Q10: **Do you seal bridge decks?**	No
Q11: What type of sealers do you allow/specify?	*Respondent skipped this question*
Q12: What is the application rate for each sealer?	*Respondent skipped this question*
Q13: What is the typical performance life of a sealed joint?	*Respondent skipped this question*
Q14: **If you seal bridge decks, how often do you retreat?**	No
Q15: Please attach a link to approved products list and approval process for joint sealants.	*Respondent skipped this question*
Q16: **Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.**	No

Q17: **Any additional comments?**

You have a typo in Question #2.

#24 COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, April 05, 2016 10:04:09 AM
Last Modified: Tuesday, April 05, 2016 10:28:40 AM
Time Spent: 00:24:31
IP Address: 170.93.144.3

PAGE 1

Q1: State Representative

Name	Vicki Stewart
Agency	Maryland State highway Admin
State / Province	Maryland
Email	vstewart@sha.state.md.us

Q2: Do you a high performance bridge deck mix specification?

If yes, what are the mix design requirements?
We have 2 high performance mixes - one with lightweight aggregate and one with normal weight aggregate. compressive strength is 4200 PSI with all other mix requirements as standard. It was designed for 75 year service life with a long durability factor - not high strength factor.

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
flyash 15 - 25 % GGBFs 25 - 50 % microsilica 5 - 7%

Q4: Have you used fibers in bridge deck mixes?

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
1 1/2 inch poly propylene fibers at 1.5 lbs. per 100 weight.

Q5: Have you used shrinkage reducing admixtures in bridge decks?

No

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
reduced dead load on bridge.

Q7: What are your curing requirements for bridge decks?

7 day wet cure

Q8: Do you have smoothness requirements for bridge decks?

No

Q9: **Do you typically grind bridge decks?**	No
Q10: **Do you seal bridge decks?**	It depends
Q11: **What type of sealers do you allow/specify?**	
Silane	Specify
Siloxane	Specify
Methylmethacrylate	Allow
Other	Allow
Additional Comments?	50/50 boiled linseed oil and kerosene
Q12: **What is the application rate for each sealer?**	
Additional Comments?	per manufacturers recommendations
Q13: What is the typical performance life of a sealed joint?	*Respondent skipped this question*
Q14: **If you seal bridge decks, how often do you retreat?**	No
Q15: Please attach a link to approved products list and approval process for joint sealants.	*Respondent skipped this question*
Q16: **Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.**	If Yes, what is it? per manufacturers mix design
Q17: Any additional comments?	*Respondent skipped this question*

#8

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Wednesday, March 16, 2016 12:36:47 PM
Last Modified: Wednesday, March 16, 2016 1:21:55 PM
Time Spent: 00:45:07
IP Address: 204.24.68.74

PAGE 1

Q1: State Representative

Name	John Staton
Agency	Michigan DOT
State / Province	Michigan
Email	statonj@michigan.gov

Q2: Do you a high performance bridge deck mix specification?

If yes, what are the mix design requirements?
517-658 lbs/cyd total cementitious materials. Mandatory 25-40 percent cement replacement with slag cement or fly ash. Optimized aggregate gradation. ASR testing requirements for the fine aggregate.

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
25 - 40 percent replacement of the cement with either slag cement or fly ash.

Q4: Have you used fibers in bridge deck mixes?

No

Q5: Have you used shrinkage reducing admixtures in bridge decks?

No

Q6: Have you used lightweight aggregate in bridge deck mixes?

No

Q7: What are your curing requirements for bridge decks?

Two phased 7 day wet cure: Presoak burlap sheets for minimum 12 hours prior to concrete placement. When sheen has left fresh concrete surface, apply single coat of curing compound. Drain the soaked burlap to remove excessive water that may dilute or damage the fresh concrete. Apply the wet burlap as soon as the curing compound on the fresh concrete deck surface has sufficiently dried to prevent adhesion or damage to the concrete surface. Apply a network of perforated soaker hoses over the wet burlap as soon as the concrete can support it without deformation. Demonstrate that the soaker hose system will provide uniform and thorough coverage of the deck surface. Place a 4 mil minimum layer of transparent or white polyethylene sheeting over the soaker hose system , overlapping seams at least 10 inches. Maintain continuous wet cure until the concrete has attained 7 day compressive strength, but not less than 7 days of continuous wet curing.

Q8: Do you have smoothness requirements for bridge decks?	If yes, what criteria do you use and how is it measured. For standalone new bridge decks: straight edge requirements of 1/8 inch in 10 feet. For bridges included in new corridor construction: Ride quality measurements are attained using either a lightweight or high speed profilometer with a line laser. The maximum mean roughness index (MRI) is 130 inches per mile.
Q9: Do you typically grind bridge decks?	For what reason? Smoothness, Noise, Other? smoothness.
Q10: Do you seal bridge decks?	No

Q11: What type of sealers do you allow/specify?

Silane	Do not use
Siloxane	Do not use
Methylmethacrylate	Do not use
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Do not use
Other	Do not use
Additional Comments?	Under preventive maintenance, we do apply a two-coat epoxy/chip overlay to seal the deck surface if the crack density warrants wholesale sealing.

Q12: What is the application rate for each sealer?

Silane	Do not use
Siloxane	Do not use
Methylmethacrylate	Do not use
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Do not use
Additional Comments?	two-coat broom and seed application.

Q13: What is the typical performance life of a sealed joint?

Our current bridge decks are jointless, integral or semi-integral design.

Q14: If you seal bridge decks, how often do you retreat?	*Respondent skipped this question*
Q15: Please attach a link to approved products list and approval process for joint sealants.	*Respondent skipped this question*
Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.	If Yes, what is it? Prepackaged dry mix from the list of products included in the special provision. A copy of the special provision is available.

MICHIGAN
DEPARTMENT OF TRANSPORTATION

SPECIAL PROVISION
FOR
SHOTCRETING VERTICAL AND OVERHEAD STRUCTURE REPAIRS

a. Description. Shotcreting vertical and overhead structure repairs consists of shallow repairs in vertical or overhead concrete using a dry-mix shotcrete method, including preparation, placement, and finishing of the repair. Repair locations will be determined by the Engineer. Perform all work according to the Standard Specifications for Construction and ACI 506.2 – 95 Standard Specification for Construction, published by the American Concrete Institute (ACI), except as modified herein.

b. Materials. Patching materials to be used include Thoroc SP10, King MS-D1, Sikacem 133, or approved equal.

c. Construction.

1. **Surface Preparation.** Do not patch overhead areas deeper than 3 inches. Do not patch vertical areas deeper than 6 inches. Remove all unsound or loose concrete using air hammers or by grinding. Hammers heavier than the nominal 30 pound class are not permitted unless approved by the Engineer. Saw-cut the perimeter of the area to be patched, as determined by the Engineer, to a minimum edge depth of 0.5 inches. Thickness per lift shall not exceed the manufacturer's recommendation. When reinforcing steel is exposed, remove the concrete to a minimum depth of 0.75 inches behind the steel. Furnish and install 2 inch x 2 inch – 12 gauge galvanized welded wire reinforcing according to subsection 710.03.D.2 of the Standard Specifications for Construction.

Clean the reinforcing steel of all scale or rust by sandblasting or other methods approved by the Engineer. Exposed surfaces shall be cleaned by sandblasting to remove all debris followed by air blasting with oil-free compressed air having a minimum pressure of 90 psi. Where the areas to be patched are adjacent to a joint, install necessary edge forms to proper line. Flush the sound, cleaned area for patching with clean water under pressure, immediately prior to application of the shotcreting mixture.

2. **Mixture Placement and Finishing.** The nozzleman must be ACI certified for the dry-mix process for vertical and overhead positions. Protect the adjacent environment according to subsection 715.03.D.4 of the Standard Specifications for Construction. Place the patching mixture using equipment approved by the Engineer, in quantities which can be placed and finished before hardening begins. Place and finish the patching mixture according to the manufacturer's recommendations. Failure of the nozzleman to produce a satisfactory repair will result in re-evaluation or rejection of the nozzleman.

3. **Curing.** Cure patching mixtures according to the manufacturer's recommendations. Do not place patching mixtures if the ambient air temperature is less than 45 degrees F, or greater than 90 degrees F. Do not place shotcrete against frozen surfaces.

d. Acceptance. Obtain and submit to the Engineer daily two, 2" diameter cores of the previous day's work for evaluation, according to ASTM C 1604. The Department will perform a condition inspection on all repairs thirty days after the repairs are completed. All repairs that fail will be considered unacceptable work and must be removed and replaced to the satisfaction of the Engineer, at no additional cost to the Department. Failure of a repair is considered to be sagging of the repair material, bond loss, sandy pockets, and/or delamination. Delaminations will be detected by sounding with a hammer or steel bar. Complete the above work prior to final project acceptance. Repair damage to any in-place pavement, roadway structure, or appurtenance caused by the Contractor's operations as directed by the Engineer, at no cost to the Department.

e. Measurement and Payment. The completed work as described will be paid for at the contract unit price for the following contract item (pay item):

Contract Item (Pay Item)	**Pay Unit**
Vertical and Overhead Structure Repairs, Shotcrete	Cubic Foot

Vertical and Overhead Structure Repairs, Shotcrete will be measured by volume in cubic feet as determined from the theoretical yield of the commercial patching mixture used, with deductions made for material wasted or rejected. Payment includes all labor, equipment and material necessary to complete the work according to this special provision.

#17

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Saturday, April 02, 2016 2:28:26 PM
Last Modified: Saturday, April 02, 2016 2:45:52 PM
Time Spent: 00:17:25
IP Address: 108.171.131.160

PAGE 1

Q1: State Representative

Name	Paul Rowekamp
Agency	Minnesota DOT Bridge Office
State / Province	Mn
Email	paul.rowekamp@state.mn.us

Q2: Do you a high performance bridge deck mix specification?

If yes, what are the mix design requirements?
See attachment.

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
Fly ash – 30% max Slag – 35% max Silica Fume – 5% Ternary – 40% max

Q4: Have you used fibers in bridge deck mixes?

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
Yes, we have used fibers (see below) but are still experimenting and haven't developed a final spec. Propex Novomesh 950 at 7.5, 5.0 and 4.0 lbs/cu yd. PVA fibers 4.0 lbs/ cu yd. BASF MAC Matrix and BASF M100 (4.0-MAC , .5-M100) 4.5 lbs/cu yd. BASF MAC Matrix at 3.0 and 4.0 lbs /cu yd

Q5: Have you used shrinkage reducing admixtures in bridge decks?

No,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
No, we are concerned about freeze/thaw damage and long term durability.

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
We just started 2 projects that will use lightweight fine aggregate for internal curing. The lightweight sand content was limited to 10% of the total aggregate volume. We also are about to start a project using lightweight aggregate to reduce the dead load, but the mix will be done by the contractor and has not yet been submitted.

Q7: What are your curing requirements for bridge decks?

See attachment.

Q8: Do you have smoothness requirements for bridge decks?

If yes, what criteria do you use and how is it measured.
Yes, MnDOT Spec 2401.3.F.3.b (for monolithic deck slab) and 2404.3.D (2" wearing course) both require a final surface finish of 1/8" in 10' longitudinally when checked with a 10 foot straightedge.

Q9: Do you typically grind bridge decks?

For what reason? Smoothness, Noise, Other?
Yes, for smoothness and noise.

Q10: Do you seal bridge decks?

Additional Comments
We do not have a general policy requiring bridge deck sealing but do occasionally seal decks with rain damage or to seal to large areas of decks that exhibit cracking (more than can be sealed using conventional methods for sealing individual cracks).

Q11: What type of sealers do you allow/specify?

Silane	Specify
Siloxane	Do not use
Methylmethacrylate	Specify
Epoxy Chip Seal	Specify
Polymer Modified Overlay	Specify

Q12: What is the application rate for each sealer?

Silane	Specify
Siloxane	Do not use
Methylmethacrylate	Specify
Epoxy Chip Seal	Specify
Polymer Modified Overlay	Specify
Additional Comments?	Silane 40%=125sqft/gal to 100%=400 sqft/gal Methylmethacrylate – per manufacturer Epoxy Chip Seal – two layers Polymer Modified Overlay = 2 inch thick overlay

Q13: What is the typical performance life of a sealed joint?

Hot-poured crumb rubber – 4 years
Silicone - 10 years?
Strip seals - 15-20 years

Q14: If you seal bridge decks, how often do you retreat?

If Yes, what is it? Does your Agency retreat or do you let a Contract for the work?
Have not established a retreat time period (have only been sealing decks for a few years). Some sealing is done by district bridge crews. Most is done by contract.

Q15: Please attach a link to approved products list and approval process for joint sealants.

http://www.dot.state.mn.us/products/index.html

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.

If Yes, what is it? See attached.

Q17: Any additional comments?

Attachments will be emailed to Denise Wagner

MnDOT

Question No. 2 Do you a high performance bridge deck mix specification? If yes, what are the mix design requirements?

Concrete Mix Design Requirements

Design and produce 3YHPC-M or 3YPHC-S concrete mixes based on an absolute volume of 27.0 ft^3 [1.0 m^3] in accordance with the Table HPC-4 and the following requirements:

Table HPC-4
High Performance Bridge Deck Concrete Mix Design Requirements

Concrete Grade	Mix Number *	Intended Use	w/c ratio	Target Air Content	Maximum %SCM (Fly Ash/Slag/ Silica Fume/ Ternary) ‖	Slump Range †, *inches*	Minimum Compressive Strength, f'c (28-day)
HPC	3YHPC-M	Bridge Deck – Monolithic	0.42-0.45	6.5%	30/35/5/40	1 - 4	4000 psi
	3YHPC-S	Bridge – Structural Slab					

* Provide a Job Mix Formula in accordance with 2401.2.A.7. Use any good standard practice to develop a job mix formula and gradation working range by using procedures such as but not limited to 8-18, 8-20 gradation control, Shilstone process, FHWA 0.45 power chart or any other performance related gradation control to produce a workable and pumpable concrete mixture meeting all the requirements of this contract.

‖ The individual limits of each SCM shall apply to ternary mixtures.

† Keep the consistency of the concrete uniform during entire placement.

Required Preliminary Testing

Prior to placement of any 3YHPC-M or 3YHPC-S Concrete, the Engineer will require preliminary batching and testing of the concrete mix design.

Submit the concrete mixes using the appropriate MnDOT Contractor Mix Design Submittal Workbook available on the Department's website at least 14 calendar days prior to the beginning of preliminary laboratory mixing and testing of the proposed mix designs. Any changes or adjustments to the material or mix design require a new Contractor mix design submittal. For mix design calculations, the Engineer, in conjunction with the Concrete Engineer, will provide specific gravity and absorption data.

The Concrete Engineer, in conjunction with the Engineer, will review the mix design submittal for compliance with the contract.

Test the concrete for the following hardened concrete properties in accordance with Table HPC-5:

Table HPC-5
Required Hardened Concrete Properties for Mixes 3YHPC-M and 3YHPC-S

Test	Requirement	Test Method
Required Strength (Average of 3 cylinders)	4000 psi at 28 days	ASTM C31
Rapid Chloride Permeability	≤ 2500 coulombs at 28 days (For Preliminary Approval) ≤ 1500 coulombs at 56 days	ASTM C1202
Freeze-Thaw Durability	Greater than 90% at 300 cycles	ASTM C666 Procedure A
Shrinkage	No greater than 0.040 percent at 28 days	ASTM C157
Scaling	Visual rating not greater than 1 at 50 cycles	ASTM C672

The Engineer will allow the maturity method for subsequent strength determination. Perform all maturity testing in accordance with ASTM C1074 and the MnDOT Concrete Manual.

If a mix is approved, the Concrete Engineer will consider the mix design and testing as acceptable for a period of 5 years provided the actual concrete mixed and placed in the field meets the Contract Requirements. The Concrete Engineer will not require new testing within that 5-year period as long as all the constituents (including the aggregates) of the proposed mix design are the same as the original mix design.

The Engineer determines final acceptance of concrete for payment based on satisfactory field placement and performance.

Question No. 7. What are your curing requirements for bridge decks?

Bridge Deck Placement and Curing Requirements

The Engineer will not allow finishing aids or evaporation retarders for use in finishing of the concrete.

The Contractor is fully responsible for curing methods. Comply with the following curing methods unless other methods are approved by the Engineer in writing.

Table HPC-7
Required Curing Method Based on Final Bridge Deck Surface

Bridge Deck Type	Final Bridge Deck Surface	Required Curing Method ‖
Bridge structural slab curing (3YHPC-S)	Low Slump Wearing Course	Conventional wet curing after carpet drag
Bridge deck slab curing for full-depth decks (3YHPC-M)	Epoxy Chip Seal Wearing Course or Premixed Polymer Wearing Course	Conventional wet curing after carpet drag
	Bridge Deck Planing	Conventional wet curing after carpet drag.
	Tined Texturing*	Conventional wet curing after tine texturing AMS curing Compound after wet cure period
	Finished Sidewalk or Trail Portion of Deck (without separate pour above)*	Conventional wet curing after applying transverse broom finish AMS curing Compound after wet cure period

‖ Apply conventional wet curing to bridge slabs following the finishing machine or air screed.
* Prevent marring of broomed finish or tined textured surface by careful placement of wet curing.

Use conventional wet curing consisting of pre-wetted burlap covered with white plastic sheeting in accordance with the following:

(1) Place the burlap to cover 100 percent of the deck area without visible openings
(2) Place the wet curing within 30 min after the finishing machine completes the final strike-off of the concrete surface
(3) If the Contractor fails to place the wet curing within 30 min, the Department will monetarily deduct $500 for every 5 min period, or any portion thereof, after the initial time period until the Contractor places the wet curing as approved by the Engineer, the Department may assess the deduction more than once
(4) Keep the slab surface continuously wet for an initial curing period of at least 7 calendar days
(5) Use a work bridge to follow the finish machine and
(6) Provide an additional center rail on wide bridges, if necessary.

Where marring of the broomed finish or tined texturing surface finish is a concern, the Engineer may authorize curing as follows:

(1) Apply a membrane curing compound meeting the requirements of 3754, "Poly-Alpha Methylsytrene (AMS) Membrane Curing Compound"
(2) Apply curing compound using approved power-operated spray equipment
(3) Provide a uniform, solid white, opaque coverage of membrane cure material on exposed concrete surfaces (equal to a white sheet of paper)
(4) Place the membrane cure within 30 min of concrete placement unless otherwise directed by the Engineer
(5) Provide curing compound for moisture retention until the placement of a conventional wet curing
(6) Apply conventional wet curing when walking on the concrete will not produce imprints deeper than $^{1}/_{16}$ in [1.6 mm]
(7) Keep the deck slab surface continuously wet for an initial curing period of at least 7 calendar days including weekends, holidays, or both if these fall within the 7-calendar-day curing period
(8) The Engineer will not allow placement of membrane curing compound on any concrete surface that expects future placement of additional concrete on that surface and
(9) If the Contractor fails to meet these requirements, the Department may reduce the contract unit price for the concrete item in accordance with 1512, "Conformity with Contract Documents."

MnDOT

Question No. 16. Shotcrete specification

1-29-2014

SB-XX CONCRETE SURFACE REPAIR

SB-XX.1 Description of Work

This work consists of repairing spalled and deteriorated concrete surfaces on various bridges in the Project. Perform the work in accordance with the applicable provisions of MnDOT 2433, the Plans, as directed by the Engineer, and the requirements described herein.

SB-XX.2 Shotcrete Processes

Shotcrete may be furnished and applied by either the *dry-mix* or *wet-mix* process. The *dry-mix* process consists of a dry mixture of Portland cement and aggregates conveyed through a hose and mixed with water at the nozzle as it is pneumatically projected onto a substrate. The *wet-mix* process consists of thoroughly mixing all ingredients, except accelerating admixtures, including the mixing water, and introducing the mixture into the delivery equipment to be air-jetted from the nozzle at high velocity onto the substrate surface. Additional descriptive information can be found in the American Concrete Institute ACI 506R "Guide to Shotcrete."

SB-XX.3 Shotcrete Specifications

Shotcreting shall conform to all applicable requirements of "Specification for Shotcrete (ACI 506.2-95)" and as referenced herein to "Guide to Shotcrete (ACI 506R-90)" contained in the latest edition of the ACI Guide to Concrete Practice, Part 5 published by the American Concrete Institute (ACI); and the following special provisions:

SB-XX.4 Submittals for Shotcreting Operations

Submit the following written documentation at least 10 days prior to commencement of shotcreting operations:

A. Qualifications of Shotcrete Work Crew

The shotcrete crew foreman shall have had at least five years experience in shotcrete repair work on projects of similar size and character. Provide five references of those responsible for supervision of similar projects. Include name, address and telephone number of references who will testify to the successful completion of these projects by the shotcrete crew foreman.

Nozzle operators shall have successfully completed three projects of similar size and character. Provide three references of those responsible for supervision of these projects. Nozzle operators shall also pass a test, described in SB-12.8C, demonstrating their competence.

B. The application process that will be used (wet or dry), a description of the proposed method of application, and a description of the mixing and application equipment.

C. Details of proposed shotcrete mixture(s), including proportions and means of supply, and test results of compressive strength of concrete specimens for mix designs proposed by the Contractor.

D. A description of the proposed curing procedures and protection to be provided to shotcrete.

E. A description of the proposed quality control testing program. Testing of shotcrete work shall be in accordance with the requirements of ACI 506.2.1.6 Quality Assurance, or as otherwise specified.

Note the time required for this testing and approval process in developing the testing schedule. Carry out the tests at curing temperatures expected to be encountered in the field.

The Engineer will either approve or reject the Contractor's submittals within 10 calendar days after receipt of the complete submission. Wall construction will not be allowed to begin nor materials incorporated into the work until the submittal requirements are satisfied and found acceptable to the Engineer. Resubmit for approval, any changes or deviations required by the Engineer. No adjustments in Contract time will be allowed due to incomplete submittals.

SB-XX.5 Materials

A. Portland cement shall conform to 3101, Type I. Air entrainment is not required.

B. Water shall conform to 3906.

C. Fine aggregate shall be natural siliceous and consisting of hard, clean, strong, durable and uncoated particles, conforming to the requirements of ASTM C 33. Gradation shall be even from fine to coarse and shall be within the following limits:

Sieve Size	**Percent Passing**
9.50 mm **(3/3 inch)**	100
4.75 mm **(#4)**	95-100
2.36 mm **(#8)**	80-100
1.18 mm **(#16)**	55-85
600 µm **(#30)**	25-60
300 µm **(#50)**	10-30
150 µm **(#100)**	2-10

D. Reinforcement for surface repair shall conform to 3301 and/or 3303. Epoxy coated or galvanized material may be used, but is not required. Inserts for steel fabric shall be galvanized and of adequate length and strength to resist a 2250-pound pull-out force.

E. No admixtures, except air-entraining admixtures, shall be added to the shotcrete *without* approval of the Engineer. Admixtures shall contain no chlorides or other materials corrosive to steel or materials that may cause other detrimental effects such as cracking or spalling. A documented history of demonstrated satisfactory performance in a mix of similar proportions shall be submitted to the Engineer.

F. Handle, transport and store all *dry* shotcrete material with adequate provisions for the prevention of absorption of moisture. Maintain ambient temperatures in a temperature range of 40º F to 85º F.

SB-XX.6 Shotcrete Proportioning

The Contractor is responsible for shotcrete mixture proportioning. Submit the following information to the Engineer for review and approval per SB-XX.4.

A. An easily identifiable mix designation, number or code.

B. For a *dry-mix* process, batch quantities of fine aggregate, coarse aggregate, cement, expected water demand (to include all water from moisture in aggregates, and water added in the pre-moisturizer and at the nozzle) and all other shotcrete ingredients, in lbs/ft.^{3}, based on saturated surface-dry aggregates.

C. Aggregate Source, Gradation, Relative Bulk Density and Absorption.

Proportion shotcrete to meet the following minimum performance requirements:

TEST DESCRIPTION	TEST METHOD	AGE (Days)	SPECIFIED REQUIREMENT
Min. Compressive Strength (psi)	ASTM C 39 ASTM C 42	7 28	4000 5000
Max. Boiled Absorption, %	ASTM C 642	7	8
Max Volume of Permeable Voids, %		7	17

Make allowances for the shooting orientation and rebound in shotcrete mixture proportioning.

SB-XX.7 Supply and Equipment

A. Batching, Mixing and Supply

Batch, mix and supply *dry-mix* shotcrete as dry-bagged premix material packaged in small bags of approximately 66 pounds each. Dry-bagged premixed shotcrete materials shall be produced in conformance with the pertinent requirements of ASTM C 387. In particular, all aggregates shall be dried to a moisture content of less than 0.1% by mass, based on oven drying at 220º F to 230º F.

B. Shotcrete Placing Equipment

1. *Dry-mix* Placing Equipment

Shotcrete supply equipment shall be capable of discharging the *dry-mix* shotcrete materials without segregation.

Pre-dampen dry-bagged premixed shotcrete materials to provide consistent moisture content in the range of 3% to 5% by mass in a pre-dampener, prior to discharge into the shotcrete gun. Discharge of completely dry materials into the shotcrete gun will not be permitted, unless satisfactory performance is demonstrated in the test panel per SB-12.8C.

The mixing and pre-dampening units shall be capable of producing a shotcrete mixture with uniform moisture content, such that the nozzle operator is not required to repeatedly adjust the water content at the nozzle water ring.

The delivery equipment (gun) shall be capable of discharging a continuous, smooth stream of uniformly mixed material into the delivery hose.

The discharge nozzle shall be equipped with a manually operated perforated water feed ring inside the nozzle. The water valve shall be capable of ready adjustment to vary the quantity of water and shall be convenient to the nozzle operator.

Water pressure at the discharge nozzle shall be sufficiently greater than the operating air pressure so that the water is intimately mixed with the pre-dampened shotcrete materials. If the line water pressure is inadequate, a water booster pump shall be introduced into the water line to provide a steady, non-pulsating water pressure.

Supply a clean, dry air supply, capable of maintaining sufficient nozzle velocity for all parts of the work. The air supply shall contain a moisture and oil trap to prevent contamination of the shotcrete.

2. *Wet-mix* placing equipment shall include a clean, dry, oil-free supply of compressed air sufficient for maintaining adequate nozzle velocity at all times. The equipment shall be capable of delivering the premixed material accurately, uniformly and continuously through the delivery hose.

SB-XX.8 Quality Assurance and Quality Control Testing

A. Quality Control Testing

Establish and maintain a quality control program for all shotcrete work. Such a program shall include, but not be limited to the following:

1. Maintenance of test records for all quality control operations;

2. Wash-out testing of dry-bagged premix materials to check cementitious content and aggregate gradation.

3. Physical testing of the hardened shotcrete.

B. Preconstruction Trials

Implement a preconstruction trial to enable the Engineer to evaluate conformance of the proposed materials, shotcrete mixture, equipment and crew to the Project specifications. Acceptance of the preconstruction trial results by the Engineer is required prior to performance of any work on the Project.

C. Construction Testing

Shoot a single construction test panel for the repair work by *each* nozzle operator. The test panel shall be shot in the same position as the work being done.

Produce a test panel in accordance with the requirements of ASTM C 1140, but with minimum dimensions of 18 inches x 18 inches x 4 inches deep and be constructed of wood and sealed plywood; with 45º sloping edge forms to permit escape of rebound. There shall be no reinforcement or embedments within the panel.

The construction test panel shall be stored, handled and cured in accordance with 2461.4A5. After curing, the panel shall be cored or cut to provide compression test specimens as described below.

Cut 3-inch diameter core compressive strength test specimens from the test panel--with length/diameter ratios preferably 2:1 and not less than 1:1; or 3-inch cubes. Provide two test specimens.

Conduct compressive strength tests in accordance with ASTM C 42. The mean compressive strength for a set of two specimens shall equal or exceed f'_c. Correct compressive strengths to equivalent 2:1 cores, using the core correction factors in C 42. Test one specimen at age 3 days and one specimen at age 28 days.

SB-XX.9 Surface Preparation for Shotcreting

The Engineer will locate and outline all loose, spalled and deteriorated concrete to be removed. Exercise care so as to not damage areas of sound concrete or reinforcing steel during concrete removal operations. Unless specifically directed by the Engineer, depth of removal shall not exceed 4 inches.

Accomplish concrete removal using one or more of the following methods:

1. Chipping with hand picks, chisels or light duty jackhammers not to exceed 15 pounds;

2. Scarifiers, scabblers or other suitable mechanical means; and/or

3. High-pressure (14,500 to 40,000 psi) water jetting.

If sound concrete is encountered before existing reinforcing steel is exposed, prepare and repair the surface without further removal of concrete. When corroded reinforcing steel is exposed, continue concrete removal until there is a minimum one-inch clearance around the exposed corroded reinforcing bar. Take care to not damage bond to adjacent non-exposed reinforcing steel during the concrete removal process.

If inplace reinforcement displaying deep pitting or loss of more than 20% of cross-sectional area is encountered, the Engineer will discuss the need for additional reinforcement with the MnDOT Bridge Office. If so directed by the Engineer, remove loose reinforcement and replace with equal size bars. Minimum lap splice length of all replacement and new reinforcement shall be as detailed in the Plans. In the case of lapped splices, do not bundle bars, but place the bars such that the minimum spacing around each bar is three times the maximum aggregate size or ¾-inch, whichever is larger, to allow for proper encapsulation with shotcrete.

Taper the perimeter of all areas where concrete is removed at an approximate 45º angle, except sawcut the outer edges of all chipped areas to a minimum depth of 1/2-inch to prevent feather edging, unless otherwise approved by the Engineer.

After all deteriorated concrete has been removed; prepare the repair surface to receive shotcrete by sandblasting or high-pressure (14,500 to 40,000 psi) water jetting. The repair surface shall have an adequate surface roughness determined as three peak-to-valley measurements of 3/16 inch.

Remove by sandblasting or high-pressure water jetting all fractured surface concrete and all traces of any unsound material or contaminants such as oil, grease, dirt, or any materials which could interfere with the bond of freshly placed shotcrete.

Apply shotcrete to cleaned areas within 48 hours, or shall be re-blasted.

Dispose of all material removed in accordance with the requirements of 2104.3C3.

SB-XX.10 Shotcrete Application for Surface Repair

A. General

Apply shotcrete in accordance with good practice as detailed in Chapter 8, Section 8.5 of ACI 506R. In particular:

1. Operate the nozzle generally operated at a distance of 1.5 to 5 feet from the receiving surface and orient at right angles to the receiving surface, except as required to fill corners, cover edges and encase large diameter reinforcement bars.

2. Optimize the combination of air pressure at the nozzle, moisture content of the shotcrete and the distance of the nozzle from the receiving surface to achieve maximum compaction of the shotcrete.

3. Take care while encasing reinforcement and steel fabric to keep the front face of the reinforcement clean during shooting operations so that shotcrete builds up from behind to encase the reinforcement and prevent voids and sand pockets from forming.

4. Continuously remove accumulations of rebound and overspray by the blowpipe operator in advance of the deposition of new shotcrete. Do not reuse rebound material.

B. Surface Repair

All concrete surface areas to be repaired must be inspected and approved by the Engineer prior to application of any shotcrete.

The day before shotcreting, saturate the concrete substrate within the areas to be repaired and then re-wet prior to shooting. At least one hour prior to application of shotcrete, flush all surfaces to be shotcreted with water. Allow wetted surfaces to dry back to a saturated-surface-dry condition prior to application of shotcrete. If necessary, use a blowpipe to facilitate removal of surface water. Only oil-free compressed air may be used in the blowpipe. In the event a work stoppage longer than two hours takes place on any shotcrete layer prior to the time it has been built up to required thickness, re-wet the surface prior to continuing. Do not apply shotcrete to a dry surface or to a surface with free water.

Bring the shotcrete to an even plane and to well-formed corners by working up to ground wires or other guides, using a lower-than-normal placing velocity.

Do not apply shotcrete during periods of rain or high wind, which could interfere with the shotcrete stream unless suitable protective covers, enclosures or wind breaks are installed.

Exercise care to protect adjacent surfaces from build-up of rebound and overspray. Rebound will not be permitted in the completed work. Remove hardened rebound and hardened overspray prior to application of additional shotcrete using sandblasting, chipping hammers, high-pressure water blasting or other suitable techniques.

Repair shotcrete surface defects as soon as possible after placement. Remove and replace shotcrete which exhibits segregation, honeycombing, lamination, voids, or sand pockets. In-place shotcrete determined not to meet the specified strength requirement will be subject to remediation as determined by the Engineer. Possible remediation options include placement of additional shotcrete thickness or removal and replacement, all at the Contractor's expense.

For *dry-mix* application, carefully monitor the water ring in the nozzle for any signs of blockage of individual water spray holes. If non-uniform wetting of discharged shotcrete becomes apparent, stop the shooting and clean the water ring or take other appropriate corrective actions.

Thoroughly clean the delivery equipment at the end of each shift. Remove any build-up of coatings in the delivery hose and nozzle liner.

Protect the shotcrete if it must be placed when the ambient temperature is below 50º F and falling or when it is likely to be subjected to freezing temperatures before gaining sufficient strength. Maintain cold weather protection until the in-place compressive strength of the shotcrete is greater than 725 psi. Cold weather protection includes blankets, heating under tents, or other means acceptable to the Engineer. The temperature of the shotcrete mix, when deposited, shall be not less than 50º F or more than 95º F. Terminate shotcrete application if the ambient temperature rises above 85º F, unless the Contractor adopts special hot weather shotcreting procedures that are approved by the Engineer.

If the prevailing ambient conditions are such that the shotcrete develops plastic shrinkage and/or early drying shrinkage cracking, terminate shotcrete application and take the following action:

1. Reschedule the work to a time when more favorable ambient conditions prevail; and/or

2. Adopt corrective measures, such as installation of sun-screens, windbreaks, surface evaporation retardants or fogging devices to protect the work.

SB-XX.11 Shotcrete Finishing

Build up the surface of the shotcrete slightly and trim to the final surface by cutting with the leading edge of a sharp trowel. Remove any imperfections by floating with a rubber float. Limit work done to the finished surface to correcting imperfections caused by cutting with the trowel. Accomplish final finishing by using a wood float for a preliminary finish, with the final finish using a rubber float. Trim back all shotcrete and overspray from adjacent non-prepared concrete surfaces.

The final shotcrete surface shall not vary more than 3/8-inch from a straight line in any direction between adjacent inplace surfaces. Transitions on all surfaces shall be smooth and not abrupt. Changes or sharp edges will be permitted to remain. Diamond grinding may be used to bring the hardened surface into tolerance, but the ground surface must not result in an objectionable appearance after final surface finishing, as determined by the Engineer.

SB-XX.12 Shotcrete Curing

On completion of finishing of a repaired area, prevent shotcrete from drying out by immediately fogging, wetting or applying curing compound. Once shotcrete has attained final set, keep it continuously moist or cure for a minimum period of 3 days. Accomplish moist curing using one or more of the following procedures:

1. Wrap the elements in wet burlap, which has been presoaked in water for 24 hours prior to installation. Wrapping the wet burlap in plastic is useful for retarding the rate of drying of the burlap.

2. Install sprinklers, soaker hoses or other devices to keep the shotcrete surface continuously, wet. The use of intermittent wetting procedures that allow the shotcrete to undergo wetting and drying during the curing period will not be allowed.

3. Apply tinted curing compound per SB-12.5B to exposed repaired areas. Apply other approved curing compounds to unexposed repaired areas.

SB-XX.13 Shotcrete Acceptance

Shotcrete that does not conform to these special provisions may be subject to rejection either during the shotcrete application process, or on the basis of tests on the test panels or completed work.

Deficiencies observed during the shotcrete application process, such as, but not limited to:

1. Failure to properly control and remove build-up of overspray and rebound;

2. Incomplete encasement of or incomplete consolidation around reinforcement bars, steel fabric or anchors;

3. Incorporation of sand lenses, excessive voids, delaminations, sags, rebound, and sloughing; or

4. Failure to apply shotcrete to the required surface tolerance

Whenever possible, perform all remedial work to correct deficiencies while the shotcrete is still plastic.

Repair or remove shotcrete that is determined by the Engineer to be defective or non-conforming to the Project specifications based on evaluation of cores from the finished shotcrete. Replace the shotcrete at no cost to the Department. Repairs of non-conforming shotcrete are subject to the same testing, evaluation and acceptance criteria as the original repair shotcrete.

SB-XX.14 Shotcrete Repair

Remove while still plastic shotcrete that is identified as being non-conforming using spades, scrapers or other suitable mechanical devices. High-pressure water jetting may be used, subject to acceptable disposal of the removed shotcrete.

Remove hardened shotcrete that is identified as being non-conforming using the same basic procedures used for removal of deteriorated concrete. Take care to avoid damage to reinforcement, steel fabric or anchors. Replace any embedment damaged during the shotcrete removal process at no cost to the Department.

Place, finish, cure and protect repair shotcrete in the same manner specified for all shotcrete work. Apply tinted curing compound per SB-12.5B to all exposed concrete surfaces of repaired areas. The Contractor shall bear the costs of all repair and tests for non-conforming shotcrete.

SB-XX.15 Method of Measurement

Measurement will be by area in square feet of concrete surface repaired as indicated in the Plans, and other areas that have been specifically designated and/or approved by the Engineer for repair by this method. Work outside of these designated areas will not be measured for payment.

SB-XX.16 Basis of Payment

Payment for Item No. 2433.618 “CONCRETE SURFACE REPAIR” will be made at the Contract price per square foot and shall be compensation in full for all costs of repairing the designated deteriorated concrete surfaces as described herein, including new reinforcement, and all incidentals thereto.

#29

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, April 08, 2016 10:03:55 AM
Last Modified: Friday, April 08, 2016 12:27:58 PM
Time Spent: 02:24:02
IP Address: 168.166.124.100

PAGE 1

Q1: State Representative

Name	Brett Trautman
Agency	Missouri DOT - Const. & Matls Div.
State / Province	Missouri
Email	Brett.Trautman@modot.mo.gov

Q2: Do you a high performance bridge deck mix specification?

No

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
Slag - Max. 30% Fly Ash (Class C & F) - Max. 25% Metakaolin - Max. 15% Silica Fume - Max. 8%

Q4: Have you used fibers in bridge deck mixes?

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
Bridge Deck Overlays Hydro existing bridge deck and place a 4 or 5 inch concrete overlay. Want a stiff concrete in order to extend the service life of the bridge deck; can't replace the bridge deck due to limited funding. Steel fibers comply with ASTM A820 Length: 1 inch Dosage: 40 to 45 lbs./cu. yd.
Orthotropic Bridge Deck - Wearing Surface Placed a 4 inch concrete overlay on steel plate. Lightweight aggregate utilized to reduce the dead load. Several shear connectors were attached to the steel plate to prevent lateral movement. Needed a new wearing surface to improve skid resistance and address structural issues. Steel fibers comply with ASTM A820 Length: 1 inch Dosage: 195 lbs./cu. yd.

Q5: Have you used shrinkage reducing admixtures in bridge decks?

No

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
Have used to reduce the dead load on the bridge. Typical mixes replace 80 to 100% of the coarse aggregate. Occasionally lightweight sand has been used. The unit weight of fresh concrete required to be between 105 to 120 lbs./cu. yd.

Q7: What are your curing requirements for bridge decks?

Immediately after texturing a Type 1-D curing compound is applied at a rate of 1 gallon per 150 sq. ft. No more than 10 linear feet of the texture concrete can be exposed without curing compound at any time. This is followed by a 7 day wet cure. Wet burlap is placed as soon as the burlap can be placed without marring the surface.

Q8: Do you have smoothness requirements for bridge decks?

If yes, what criteria do you use and how is it measured.
All variations exceeding 1/8 inch in 10 feet.

Q9: Do you typically grind bridge decks?

No

Q10: Do you seal bridge decks?

Additional Comments
A new bridge is sealed prior to opening to traffic.

Q11: What type of sealers do you allow/specify?

Silane	Specify
Siloxane	Do not use
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Allow
Additional Comments?	Methylmethacrylate, epoxy chip seal, and polymer modified overlays used on older bridge decks experience a fair amount of cracking.

Q12: What is the application rate for each sealer?

Additional Comments?	Silane - One gallon per 200 sq. ft. Epoxy chip seal - Total thickness 1/4 inch placed in two 1/8 inch lifts Methylmethacrylate and polymer modified overlays - Depends on bridge deck condition

Q13: What is the typical performance life of a sealed joint?

Strip Seal on new construction
15 to 20 years

Q14: If you seal bridge decks, how often do you retreat?

If Yes, what is it? Does your Agency retreat or do you let a Contract for the work?
Bridge Maintenance wanting to reseal bridge decks with silane every 5 to 8 years. Resealing bridge decks performed by MoDOT personnel or by contract.

Q15: Please attach a link to approved products list and approval process for joint sealants.

Pre-Acceptance List
www.modot.org/business/contractor_resources/
products.htm

Sealant Specification (Sec 1057)
www.modot.mo.gov.org/business/standards_and_specs/Sec1057.pdf

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.

No

Q17: Any additional comments?

Respondent skipped this question

#31

COMPLETE

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Q1: **State Representative**

Name	Paul Bushnell
Agency	Montana Department of Transportation
State / Province	Montana
Email	pbushnell@mt.gov

Q2: Do you a high performance bridge deck mix specification?

If yes, what are the mix design requirements? Table 551-3 Concrete Requirements Nominal Maximum Aggregate Size inches (mm) - 3/4 (19) Maximum Cementicious Materials Content, lbs/yd3 (kb/m3) - 564 (334) Indicated Compressive Strength, 28-Day, PSI (MPA) - 4000 (28) Maximum Water Cement Ratio (W/C) - 0.42 Maximum Target Value for Slump, inches (mm) - 5 Slump Tolerance, inches (mm) + 1 1/2 (37) to -2 (50) Required Air Content, (%) - 5.5-8.5 Class Deck and Overlay-SF. Design and produce class Deck and Overlay-SF concrete in accordance with Table 551-3 and the following: • Include silica fume and fly ash or GGBFS as SCMs in combination with compatible air entraining, water reducing and/or super-plasticizing admixtures. SCMs replacement quantities must meet the requirements of Subsection 551.02. • Mix requires trial batch rapid chloride permeability test results in accordance with AASHTO T 277 less than 2000 coulombs at 28 days or surface resistivity test results in accordance with AASHTO TP 95 greater than 21 kilohm-centimeters at 28 days. • Submit a batching sequence procedure with the mix design including the amount of material charged and the time before the next material will be added. Include approximate mixer revolutions for each stage of the sequence. Alternative mix designs not in accordance with Table 551-3 may be accepted provided the following requirements are met: 1. Include in the design compressive strength test results according to AASHTO T 22 for 3, 7, and 28 days. The design must produce strengths in accordance with Table 551- 3 by the specified age. 2. Include in the mix design shrinkage test results according to AASHTO T 160. The maximum allowed shrinkage for mix design acceptance is .0300% at 28 days. 3. Include in the mix design rapid chloride permeability (RCP) test results according to AASHTO T 277. The design must demonstrate a maximum of 1500 coulombs at 28 days. Alternatively, include in the mix design test results according to AASHTO TP 95, surface resistivity indication of concrete's ability to resist chloride ion penetration. The design must demonstrate a minimum of 35 Kilohms-centimeters at 28 days. 4. Include in the mix design creep test results at 28 days according to ASTM C512. 5. Include in the mix design modulus of elasticity (MOE) results according to ASTM C469. 6. Include in the mix design air-void spacing results according to ASTM C457 modified point-count method at 100x magnification. The average of all tests must not exceed 0.009 inches (0.230 mm) with no single test greater than 0.010 inches (0.260 mm). The total air content must exceed 5.5%. 7. Design and produce concrete maintaining a plastic air content of 5.5% - 8.5%. 8. Submit a batching sequence procedure with the mix design including the amount of material charged and the time before the next material will be added. Include approximate mixer revolutions for each stage of the sequence.

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
Class Deck and Overlay-SF. Design and produce class Deck and Overlay-SF concrete in accordance with Table 551-3 and the following: • Include silica fume and fly ash or GGBFS as SCMs in combination with compatible air entraining, water reducing and/or super-plasticizing admixtures. The following supplementary cementitious materials (SCMs) may be used as partial replacement for hydraulic cement in the mix design. a. Fly ash may be included in the mix design for up to 30% by weight of the total cementitious material. Combinations of various classes of fly ash may not exceed 30% by weight of the total cementitious material. b. Microsilica Fume may be included in the mix design for up to 10% by weight of the total cementitious material when a minimum of 15% fly ash or GGBFS is also included in the mix design or when the mix design incorporates acceptable blended cement. c. Metakaolin may be included in the mix design for up to 20% by weight of the total cementitious material. d. Ground granulated blast furnace slag may be included in the mix design for up to 50% by weight of the total cementitious material. When multiple SCMs are used in a design, the total replacement rate may not exceed 50% by weight of the total cementitious material.

Q4: Have you used fibers in bridge deck mixes?

It depends,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
Experimental Research project (2015) included macro-fibers and SRA

Q5: Have you used shrinkage reducing admixtures in bridge decks?

It depends,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
Experimental Research project (2015) included macro-fibers and SRA

Q6: Have you used lightweight aggregate in bridge deck mixes?

No

Q7: What are your curing requirements for bridge decks?

551.03.7 Curing Concrete
Continuously water cure any class of concrete used for bridge deck construction for 14 calendar days as specified below.
Continuously water cure class Overlay-SF for 7 calendar days as specified below.
Continuously water cure class Overlay-LM for 72 hours as specified below, followed by a dry cure. Begin the dry cure at the end of the 72-hour wet cure period by removing the burlap and the polyethylene. Allow the concrete to undergo 48 hours of dry cure. Keep the bridge closed to traffic an additional 48 hours if the air temperature falls below 50 °F (10 °C) during the cure. Allow no traffic on the overlay surface until the end of the dry cure and the transverse deck grooving has been completed.
Continuously cure all other concrete surfaces for 7 calendar days by either water curing or liquid membrane-forming curing compound as specified below. Design strength must be verified

by field-cured cylinders in accordance with AASHTO T 22. Do not place curing compounds on concrete that is still bleeding.
Protect freshly placed concrete from freezing, high temperatures, large temperature differentials, premature drying, excessive moisture, and moisture loss for the period of time necessary to develop the desired concrete properties.
Protect exposed concrete surfaces from premature drying by covering with canvas, plastic sheets with sealed joints, burlap, or other approved materials. Keep the concrete moist.
Continually moisten uncovered surfaces by fogging. Do not allow water to drip, flow, or puddle on the concrete surface during fog misting, when placing the burlap, or at any time before the concrete has achieved final set.
The concrete surfaces against forms may be cured by leaving the forms in place for at least 7 calendar days.
Keep the concrete surfaces moist after removing forms until surface repair is completed and one of the final cure methods described below is used. Surface repair includes removal of irregularities and repair of all depressions, voids, and air holes.
After placement, cure concrete surfaces as follows:
A. Water Cure. Keep all finished top surface concrete moist with a fine water mist until the burlap is placed.
Place wet burlap in accordance with Subsection 717.01.2 immediately behind concreting operations no later than 15 minutes after finishing. Do not use products having a laminated moisture barrier. Soak burlap for a minimum of 24 hours before use. Keep the burlap wet until concrete reaches sufficient strength to place soaker hoses or other effective means of providing moisture without marring the surface. Once a watering system is placed, place an approved reflective type sheeting or blanket over the watering system in accordance with Subsection 717.01.1 and cover to reduce evaporation. The entire concrete surface must remain moist throughout the full cure period. Ensure the temperature of all water used in the water cure is within 20 °F (11 °C) of the in-place concrete temperature. Secure covers and sheeting to prevent them from being lifted or displaced.
If an intermediate monomolecular film curing agent (evaporation retarder) is used, apply the monomolecular film in a light-fog application, using a pressure spray tank with an adjustable nozzle. Use a water-to-curing agent ratio and rate of application, both according to the manufacturer's recommendations. Agitate the solution before each application.
Apply the monomolecular film immediately after the final finishing operation is completed on any area. Do not perform finishing after application of the curing agent.
Use of an evaporation retarder must be approved before use by the Project Manager.
Furnish a product data sheet to the Project Manager before approval.
B. Liquid Membrane-Forming Curing Compound. Furnish and uniformly apply a liquid membrane-forming curing compound in accordance with Subsection 717.01.3 over exposed surfaces.
Deliver membrane-curing compound to the job in the manufacturer's original container, clearly labeled with the manufacturer's name and contents.
The compound must be ready to use as shipped by the manufacturer. Do not dilute the compound.
Do not use curing compound without providing the Project Manager a manufacturer's product data sheet.
Use white-pigmented compound for pavements.
Use a clear compound containing a fugitive dye on curbs, sidewalks, barrier rail, substructure components, and superstructure components other than those requiring a water cure. The clear compound must contain a fugitive dye that makes the film visible on the concrete for at least 4 hours after application but does not affect the concrete surfaces natural color after curing.
Thoroughly mix and apply the compound following the manufacturer's instructions or apply at a rate exceeding 1 gallon per 150 square feet (0.27 L/m2) and ensure complete coverage with no transparent areas showing obvious color differential.
Apply the curing compound immediately after the finishing operation using a mechanical pressure distribution system to provide uniform coverage. During windy conditions, equip the spray nozzles with hoods.
When concrete is placed in forms, immediately apply the curing compound after form removal if the concrete has not reached its design strength.
A hand-operated sprayer providing uniform coverage may be used to apply liquid

A hand-operated sprayer providing uniform coverage may be used to apply liquid curing compound to areas where a mechanical sprayer is impractical.
If the curing membrane is damaged from any cause during the curing period, re-coat the damaged areas immediately.
Do not apply membrane-curing compound to construction joint surfaces. Protect exposed steel during application of curing compounds.

Q8: Do you have smoothness requirements for bridge decks?	No
Q9: Do you typically grind bridge decks?	For what reason? Smoothness, Noise, Other? Transverse grooves are ground into deck concrete
Q10: Do you seal bridge decks?	Yes

Q11: What type of sealers do you allow/specify?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Allow

Q12: What is the application rate for each sealer?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Allow
Additional Comments?	Manufacturers recommendations are followed for application rate.

Q13: What is the typical performance life of a sealed joint?

The life of a sealed joint has been observed to be anywhere from a few weeks to decades. There are many factors that affect the performance life: quality of the installation, environment, application it used in, maintenance, range of expansion/contraction.

Q14: If you seal bridge decks, how often do you retreat? No

Q15: Please attach a link to approved products list and approval process for joint sealants.

This is hard to answer without knowing specifically what is meant by joint sealant. If they mean a poured bridge joint then the answer is: MDT does not have a list of approved products for poured bridge joints. The contract specifies a two part silicone product with specific properties, the contractor selects one and proposes to use it and MDT reviews/approves the product. The QPL can be found:

http://www3.mdt.mt.gov:7782/mtstm/mtstm.stmk0009.QPL_INIT

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification. No

#9

COMPLETE

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Q1: State Representative

Name	Wally Heyen
Agency	Nebraska Department of Roads
State / Province	Nebraska
Email	wally.heyen@nebraska.gov

Q2: Do you a high performance bridge deck mix specification?

No

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
We allow IP,IT and IS.

Q4: Have you used fibers in bridge deck mixes?

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
Research only at this time.

Q5: Have you used shrinkage reducing admixtures in bridge decks?

Yes,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
On occasion, depending on the bridge design.

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
Reduce dead load on a historical bridge. 35% fine aggregate and 65% expanded shale for coarse aggregate

Q7: What are your curing requirements for bridge decks?

10 days wet cure & 7 days of white curing compound. Contractor is not allowed on the deck to do any work within the first 10 days.

Q8: Do you have smoothness requirements for bridge decks?	If yes, what criteria do you use and how is it measured. The contractor shall test the cured concrete for surface irregularities with either a 10 foot straightedge placed or operated parallel to the centerline of the roadway or some other device for measuring deviations from a plane. Variations greater than 1/8 inch shall be plainly marked for removal, except that for decks which are to receive a subsequent concrete overlay coarse, where 1/4 inch variations are allowed.
Q9: Do you typically grind bridge decks?	For what reason? Smoothness, Noise, Other? We grind to remove bumps and groove longitudinal for the tinning.
Q10: Do you seal bridge decks?	Additional Comments We do not seal new decks. One district out of eight, routinely uses solvent silane to seal bridge decks. In the last few years, Bridge Division has been programming projects for Epoxy Polymer and Asphaltic Concrete Overlays with a membrane.

Q11: What type of sealers do you allow/specify?

Silane	Specify
Siloxane	Do not use
Methylmethacrylate	Specify
Epoxy Chip Seal	Do not use
Polymer Modified Overlay	Do not use
Additional Comments?	Methylmethacrylate is used only to seal cracks on the bridge deck after construction has been completed. multi-layer epoxy polymer overlay

Q12: What is the application rate for each sealer?

Silane	Specify
Siloxane	Do not use
Methylmethacrylate	Specify
Epoxy Chip Seal	Do not use
Polymer Modified Overlay	Do not use
Other	Specify
Additional Comments?	multi-layer epoxy polymer overlay is specified.

Q13: What is the typical performance life of a sealed joint?

8-10 years

Q14: If you seal bridge decks, how often do you retreat?	*Respondent skipped this question*

Q15: Please attach a link to approved products list and approval process for joint sealants.

http://www.transportation.nebraska.gov/mat-n-tests/hotpoursealers.htm

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.

Yes

Q17: Any additional comments?

Respondent skipped this question

SECTION 735 - SHOTCRETE
(G-38-1015)

735.01 – Description

1. This work shall consist of removing unsound concrete, preparing the surfaces, and applying and curing shotcrete where indicated in the contract or as directed by the Engineer. Shotcrete consists of pneumatically applied mortar using either the wet-mix or dry-mix process.

735.02 – Material Requirements

1. All materials shall conform to the requirements in Table 735.01.

Table 735.01

Material Requirements	
Applicable Materials	**Section**
Aggregates	1033
Air-entraining admixture (wet mix only)	1007
Chemical admixtures (wet mix only)	1007
Curing material	1012
Hydraulic cement	1004
Pozzolans	1008
Reinforcing Steel	1020

2. Shotcrete Aggregate

   a. Fine aggregate shall be rounded particles conforming to AASHTO M 6 Class B including the reactive aggregate supplementary requirement, except as amended or supplemented by the following:

      (1) Material passing No. 220 sieve, AASHTO T 11 3.0% max.
      (2) Sand equivalent value, AASHTO T 176 75 min. referee method.

   b. Coarse aggregate shall conform to AASHTO M 80 Class B, except as amended or supplemented by the following:

      (1) Los Angeles abrasion, AASHTO T 96 4.0% max.
      (2) Combine the aggregates to meet the designated gradation in Table 735.02.

Table 735.02
Shotcrete Gradation Limits for Combined Aggregates

Sieve Size	Percent by Mass Passing Designated Sieve (AASHTO T27)		
	Grading Designation		
	A	B	C
¾ inch	100	100	100
½ inch	100	100	80-95
3/8 inch	100	90-100	70-90
No. 4	95-100	70-85	50-70
No. 8	80-100	50-70	35-55
No. 16	50-85	35-55	20-40
No. 30	25-60	20-35	10-30
No. 50	10-30	8-20	5-17
No. 100	2-10	2-10	2-10

3. The Contractor may elect to use reinforcing deformed steel or fibrillated polypropylene fibers conforming to ASTM C 1116. The use of reinforcing shall be pre-approved by the Engineer.

4. Project Submittals

   a. The Contractor shall submit the following to the Engineer for before the use of shotcrete:

      (1) Description of proposed equipment for mixing and applying shotcrete. Include the manufacturer instructions, recommendations.
      (2) Proposed shotcrete mix design with mix proportions.
      (3) Representative samples of shotcrete material is required.
      (4) Fiber samples, if used, with supplier or manufacturer recommendations for use.

   b. The Contractor shall submit the following to the Engineer for acceptance at least 30 days before placing shotcrete:

      (1) Project references: Include project name, owner's name, and phone numbers from at least 3 projects of comparable nature completed in the last 2 years.
      (2) Nozzle operator's experience and training. For each nozzle operator, include shotcrete application and experience on at least two projects of comparable nature.
      (3) Shotcrete supervisor experience. Include direct shotcrete application experience on comparable projects.
      (4) Testing laboratory certification. Include documentation that the strength-testing laboratory complies with ASTM C 1077 and has the experience to perform the tests specified in this Section. The testing laboratory shall be AASHTO accredited for ASTM C 1077 or demonstrate the ability to perform the requisite tests.

5. Storage and handling

   a. The Contractor shall deliver, store and handle materials to prevent contamination, segregation, corrosion or damage. The Contractor shall store liquid admixtures to prevent evaporation or freezing.

   b. The Contractor shall provide geocomposite drains in rolls wrapped with a protective covering and stored in a manner which protects the fabric from mud, dirt, dust, debris and shotcrete rebound. Extended exposure to ultra-violet light shall be avoided. The Contractor shall label each roll of fabric in the shipment to identify the production run.

6. Composition (SHOTCRETE MIX DESIGN)

   a. The Contractor shall design and produce shotcrete mixtures conforming to Table 735.03 for the type of shotcrete specified. The design shall use the amount of water required to produce shotcrete of suitable strength, consistency, quality, and uniformity with the minimum amount of rebound. The Contractor shall use the same material types and sources as submitted with mix design in the field trials and production work.

b. Fibers. IF fibers are required, the Contractor shall add them to the mix in the proportions recommended by the manufacturer.

c. Hydration stabilizing admixtures. Hydration stabilizing admixtures may be used to extend the allowable delivery time for shotcrete. Dosage is based on the time needed to delay the initial set of the shotcrete for delivery and discharge on the job. The design shall include discharge time limit in the dosage submittal. The dosage required to stabilize shotcrete shall be determined using job site material and field trial mixtures. The extended-set admixture shall control the hydration of all cement minerals and gypsum. The maximum allowable design discharge time is 3-1/2 hours.

d. If a hydration-stabilizing admixture is approved for use in the concrete mix, concrete shall be delivered and placed within the approved design discharge time limit. AN approved and compatible hydration activator may be used at the discharge site to ensure proper placement and testing.

e. The Contractor shall include the dosage and type of extended-set admixture with proposed mix design. When requested, the admixture manufacturer shall provide the service of a qualified person to assist in establishing the proper dose of extended-set admixture and make dosage adjustments required to meet changing job site conditions.

Table 735.03
Composition of Shotcrete

Type of Shotcrete Process	Minimum Cement Content		Maximum W/C(1) Ratio	Air Content Range (%)
	(kg/m^3)	(lb/cy^3)		
Wet	325	550	0.55	NA
Dry	325	550	0.50	NA
Wet (w/EA)	325	550	0.45	5 min.
Dry (w/EA)	325	550	0.45	5 min.

Notes: (1) W/C = Water/Cement (by weight)
(2) EA = Entrained Air.

7. Acceptance

a. Material for concrete will be evaluated by visual inspection of the work, conformance testing and by certification for materials manufactured off-site.

b. Compressive strength will be evaluated by ASTM C 109, Standard Test Method for Compressive Strength of Hydraulic Cements (Using 2 inch Cube Specimens). Two sets of three of 2 inch cubes will be made daily in the field. Three cubes will be tested and averaged for the final design strength of 4,000 psi in 28 days. If the compressive strength is less than 2,000 psi at 7 days, then the Engineer may require the concrete to be removed and replaced. See Table 735.04 for minimum sampling and testing requirements and acceptance quality category.

Table 735.04
Sampling and Testing of Shotcrete

Material or Product	Property or Characteristic	Category	Test Methods or Specifications
Shotcrete	Air content	---	ASTM C 231 or ASTM C 173
	Compressive Strength	II	ASTM C 31

735.03 – Equipment

1. Water Supply System. The Contractor shall provide a water storage tank at the job site. The Contractor shall provide a positive displacement pump with a regulating valve that is accurately controlled to provide water in the pressures and volumes recommended by the delivery manufacturer.

2. Mixing. The Contractor shall use equipment capable of handling and applying shotcrete containing the specified maximum size aggregate and admixtures.

3. Air Supply System. The Contractor shall use an air supply system capable of supplying the delivery machine and hose with air at the pressures and volumes recommended by the machine manufacturer. The Contractor shall provide an air hose and blowpipe to clear dust and rebound during shotcrete application. Do not use air supply systems that deliver oil-contaminated air or are incapable of maintaining constant pressure.

4. Delivery Machine. The Contractor shall use a delivery machine capable of supplying material to the delivery hose at a uniform rate. The ejection from the nozzle shall adhere to the treated surface with minimum rebound and maximum density when the nozzle is held in the range of 3 to 6 feet from the target surface.

735.04 – Construction Methods

1. Preconstruction Testing

    a. The Contractor shall conduct preconstruction shotcrete field trials before starting shotcrete production. The Contractor shall allow the Engineer the opportunity to witness all phases of the preconstruction testing.

        (1) Field Trials: The Contractor shall construct wood forms at least 6 inches thick by 2 feet by 2 feet in size. The Contractor shall have each proposed nozzle operator make test panels on two vertical wood forms. The test panels shall be cured according to AASHTO T 23, without immersing the panels. At least one of the test panels shall include reinforcement.
        (2) Coring: The Contractor shall drill nine 3 inch diameter cores from each test panel according to AASHTO T 24. NDR will immediately take possession of the cores and deliver them to the Materials & Research Central Lab.
        (3) Compressive Strength Testing: NDR will soak the cylinders in water for 40 hours immediately before testing. NDR will test three cores from each test panel at 7 days and at 28 days after field trial. NDR will perform compressive strength tests according to AASHTO T 23. All specified compressive strength requirements shall be satisfied before the shotcrete mix design will be considered for acceptance. Shotcrete production may begin after compressive strength of 4000 psi has been achieved.
        (4) Mix Design Acceptance: The Engineer will accept or reject the shotcrete mix design based on the results of the preconstruction field trials, testing and materials used. Before approving any changes to a previously accepted mix design, the Engineer may require additional preconstruction testing at no additional cost to the agency.

2. Surface Preparation and Application of Shotcrete

    a. Surface Preparation: The Contractor shall clean loose material, mud, rebound and other foreign matter from all surfaces to receive shotcrete. The Contractor shall remove curing compound on previously placed shotcrete surfaces by sandblasting. The Contractor shall install approved depth gauges to indicate the thickness of the shotcrete layers. The Contractor shall install depth gauges on 6 foot centers longitudinally and transversely with no less than two gauges per increment of surface area to receive the shotcrete. The Contractor shall sue a Type II epoxy for bonding freshly mixed concrete to hardened concrete.

    b. Weather Limitations: The Contractor shall place shotcrete when the ambient temperature is 40º F or higher.

    c. Shotcrete Application:

        (1) Do not perform shotcrete operations during high winds and heavy rains.

(2) Do not apply shotcrete to frozen surfaces.
(3) Use acceptable nozzle operators who have fabricated acceptable test panels.
(4) Apply shotcrete within 45 minutes of adding cement to the mixture. Shotcrete shall be at a temperature between 50º F and 86º F during installation.
(5) Direct the shotcrete at right angles to the receiving surface except when shooting ground reinforcing bars. Apply shotcrete in a circular fashion to build up the required layer thickness. Apply shotcrete in a steady uninterrupted flow. If the flow becomes intermittent, direct the flow away from the work area until it becomes steady.
(6) Make the surface of each shotcrete layer uniform and free of sags, drips or runs.
(7) Limit the layer thickness of each shotcrete application to 2 inches. Thicker applications may be approved if the Contractor can demonstrate that no sloughing or sagging is occurring. If additional thickness is required, broom or scarify the applied surface and allow the layer to harden. Dampen the surface before applying an additional layer.
(8) Remove laitance, loose material and rebound. Promptly remove rebound from the work area.
(9) Taper construction joints to a thin edge over a distance of at least 1 foot. Wet the joint surface before placing additional shotcrete on the joint. Do not use square construction joint.

3. Protection and Curing

a. The Contractor shall protect and cure the surface according to Section 603. For intermediate shotcrete surfaces or if a stained or finished final surface is required, the Contractor shall cure the shotcrete using an approved curing compound. If not stain or finished surface is required, apply white curing compound to the final exposed shotcrete surface according to Section 603. The Contractor shall protect and maintain shotcrete at a temperature above 40º F until shotcrete has achieved a minimum strength of 750 psi.

4. Tolerances

a. The minimum thickness of shotcrete and reinforcing cover requirements shall not be less than the design thicknesses shown on the drawings. Care shall be taken to avoid over-excavation which could damage overlying shotcrete sections by undermining or other causes.

735.05 – Method of Measurement

1. Shotcrete will be measured by the square yard.

735.06 – Basis of Payment

1.

Pay Item	**Pay Unit**
Shotcrete	Square Yard (SY)

2. Payment is full compensation for all work prescribed in this Section.

JOINT AND CRACK SEALING FILLER
(J-15-0813)

Section 1014 in the Standard Specifications is void and superseded by the following:

1014.01 – Description

Joint sealing filler shall be either a cold applied silicone product or an asphalt product (hot pour) conforming to the requirements of this Section. The type of joint filler to be used shall be as specified in the plans or special provisions. If not specified, any of the joint sealing fillers in this Section may be used.

Crack sealing filler shall be a hot pour sealer conforming to the requirements of this Section.

1014.02 -- Material Characteristics

1. NE-3405 and NE-3405LM (hot pour)

    a. NE-3405 joint and crack sealer shall conform to the requirements of ASTM D6690, Type II. The material shall conform to the requirements of Table 1 with the following exception:

        (i) The test of Bond, non-immersed, ASTM D5329, 3 specimens through 3 cycles shall be run at 0°F (-18°C), 100% extension.

    b. NE-3405LM (Low Modulus) joint and crack sealer shall conform to the requirements of ASTM D6690, Type IV. The material shall conform to the requirements of Table 1.

    c. The test of Bond, non-immersed, ASTM-D5329, will be tested on concrete blocks that will be constructed by the NDR Concrete Laboratory. The concrete blocks will be made of a 47B concrete mixture as prescribed in Section 1002 in the NDR Standard Specifications. The design is amended so that no fly ash is used in the mixture. All other specifications for Portland Cement Concrete apply.

    d. Sample conditioning, preparation and heating shall be in accordance with ASTM D 5167 with the following exceptions:

        (i) The following sentence of Section 8.1.2, “Also, if present, remove container liner by cutting it away”, is void and superseded by the following:

            “Also, if present, as much of the polyethylene bag as possible, shall be removed by cutting it away. Wholly-meltable type container in contact with the sample section shall be left in place.”

        (ii) The last sentence of Section 8.1.2 “Solid Materials” is void and superseded by the following:

            The entire vertical section which has been cut, shall be placed into the pot for melting.

        (iii) The Section of 8.2.2.1 “Solid Materials” is void.

        (iv) The Section of 8.2.3 is void and superseded by the following:

            After the solid segment is added to the melter, the material shall be allowed to minimally melt to a uniform viscous state suitable for the installation of the stirrer or paddle. The sample shall then be stirred for one full hour. The oil bath temperature shall be regulated to bring the

material to the maximum heating temperature within the one hour of stirring.

(v) The Section of 8.2.4.1 is void and superseded by the following:

During the one full hour of stirring, check the temperature of the material at maximum 15 minute intervals using a Type K thermocouple with the calibration verified in accordance with Section 6.1.7 to ensure conformance with specified temperature requirements. Stop the mechanical stirrer when measuring temperatures. If material temperatures ever exceed the maximum heating temperature, or ever drop below the minimum application temperature after the maximum heating temperature was reached, discard the sample and re-do the heating. Maintain appropriate records of times and temperatures to verify conformance with specification requirements.

(vi) The Section of 8.2.4.2 is void.

e. ASTM D 5329 shall include the following changes:

(i) Sections 6.4 and 12.4 “Specimen Preparation” shall have the reference of “177 ml (6 oz.)” replaced with “3 oz.”

(ii) Section 6 “Cone Penetration, Non-Immersed” shall be superseded with the following exceptions:

1. Section 6.5 “Procedure” is void and superseded by the following:

Place the specimen in a water bath maintained at 77 +/- 0.2°F (25 +/- 0.1°C) for two hours immediately before testing. Remove the specimen from the bath and dry the surface by shaking gently to remove free water from the surface of the specimen. Using the apparatus described in Section 6.3, make one determination at or near the center of the specimen. Take care to ensure the cone point is placed on a point in the specimen that is representative of the material itself, and is free of dust, water, bubbles, or other foreign material.

2. Section 6.6 “Report” is void and superseded by the following:

Record the value as penetration of the specimen in dmm units.

(iii) Section 12 “Resilience” shall be superseded with the following exceptions:

1. Section 12.5 “Procedure”, void the sentence “Make determinations at three points equally spaced from each other and less than 13mm (½ inch) from the container rim” and supersede with the sentence “Make one determination at or near the center of the tin.”

2. Section 12.6 “Report” is void.

2. Silicone Joint Sealer (cold applied)

a. Silicone joint sealers may be either self-leveling or non-sag and shall meet the requirements in Table 1014.01.

Table 1014.01

Silicone Joint Sealer Requirement		
Property	**Requirement**	**Test**
As supplied:		
Specific Gravity	1.010-1.515	ASTM D792
Work Time, minimum	10 minutes	
Tack-Free, at 25°C	20-360 minutes	
Cure Time, at 25°C, maximum	14 days	
Full Adhesion, maximum	21 days	
As cured, at 25°C + 1.5		
Elongation, minimum	800%	ASTM D412
Durometer		
Non-Sag, Shore A	10-25	ASTM D2240
Self-Leveling, Shore 00, minimum	40	ASTM D2240
Joint Movement Capacity	+100% to -50%	ASTM C719
Tensile Stress, at 150% Elongation	45 psi	ASTM D412

1014.03 -- Packaging

1. NE-3405 and NE-3405LM

    a. The joint and crack sealer can be packaged in either cardboard box of wholly-meltable type containers.

        (i) Cardboard box containers shall be manufactured from double wall kraft board producing a minimum bursting test certification of 350 PSI (241 N/cm^2) and using water-resistant adhesives. The use of metal staples or fasteners of any kind will be prohibited for closing the lids of the boxes. Tape or other like material is acceptable.

            a. The joint and crack sealer shall be in meltable [300°F (149°C)] polyethylene bag(s).

        (ii) Wholly-meltable type containers, and any of their components, shall be fully meltable and integrational with the joint and crack sealer by the time the manufacturer's minimum application temperature is reached.

            a. The wholly-melted and integrated container must not adversely affect the test specifications of the joint and crack sealer.

2. Silicone Joint Sealer

    a. Each container shall include information regarding manufacturer and product name.

1014.04 -- Acceptance Requirements

1. NE-3405 and NE-3405LM

    a. Acceptance of the manufactured material is based on pre-approval by either on or off-site sampling. Acceptable hot pour sealant lots are listed on the NDR Approved Products List.

        (i) NDR on-site field sampling shall be in accordance with the NDR Materials Sampling Guide.

        (ii) Off-site (Proxy) sampling shall be in accordance with ASTM D 6690.

            1. Proxy sampling shall be overseen by an outside party approved by the NDR, preferably another DOT Agency. Proxy samples shall include a

manufacturer's Certificate of Compliance. Proxy samples shall also include a dated signature of origin by the Representative that is not affiliated with the manufacturer, and can either be on the Certificate of Compliance, or separate letter.

2. For convenience in both sampling and shipping samples, sample containers smaller than a manufacturer's usual production containers are allowed, as long as the sample is 1500 grams min.

3. Samples shall be sent to the NDR Bituminous Laboratory, or alternatively, sent to an NDR-approved independent laboratory for testing which will be at no cost to the Department. If a NDR-approved independent laboratory will be used for testing purposes, the NDR Bituminous Laboratory must be notified so that NDR concrete blocks for Bond testing can be sent to it.

2. Silicone Joint Sealer

a. Acceptance of applied silicone joint sealers shall be in accordance with the NDR *Materials Sampling Guide*.

b. Acceptable silicone joint sealer manufacturer products are listed on the NDR Approved Products List.

(i) For products that are not listed, approval may be based upon test results from an independent laboratory submitted to the NDR Concrete Materials Section by the manufacturer, and testing by the NDR. Approval must be made prior to product use.

#14

COMPLETE

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PAGE 1

Q1: **State Representative**

Name	Michele Maher
Agency	Nevada Department of Transportation
State / Province	Nevada
Email	mmaher@dot.state.nv.us

Q2: **Do you a high performance bridge deck mix specification?**

If yes, what are the mix design requirements?
In addition to Standard Specifications, there is a write-up with additional requirements. HPC additional requirements 501.02.01 General. Class S and SA concrete may be substituted for selected applications for Classes A, AA, D, DA, PAA, Modified A, AA, Modified D, DA, as approved by the Engineer. When the option of Class S or SA concrete is approved, submit details of a representative test section (mockup) for approval. Produce a trial batch of Class S and SA concrete, conforming to the proposed mix design. Place a test section when the atmospheric conditions approximate the conditions anticipated for placing the final work. Finish and cure the mockup according to this Section. If it is determined that the trial batch is not workable or not able to be properly placed or finished, modify the mix design or batching sequence. Submit the revised mix design and batching sequence and place another test section. Repeat the submittal and trial pour process until a workable and finished trial batch is produced. Do not place Class S or SA concrete until the mockup pour has been accepted. Prepare a Concrete Quality Control Plan (CQCP) that addresses the production, informational quality control testing, transport, contingency plans for equipment breakdown or inclement weather, placement, finish, and cure of Portland cement for foundations, abutments, superstructures, decks, drainage structures, pavement and all other pours over 100 cubic yards. The submittal of a quality control plan, revisions, and weekly reports shall be considered as a necessary portion of the work; therefore, partial payments or portions thereof, as set forth under Subsection 109.06 may not be forthcoming until this requirement is complied with. Submit a weekly report each Monday whenever there was testing or inspections performed in the previous week. Include all necessary test results and inspection reports in the weekly report. Submit the CQCP 20 working days before the start of

Submit the CQCP 20 working days before the start of work. The quality control plan shall include a specific description for concrete placement in foundations, abutments, superstructures, decks, drainage structures, pavement and all other pours over 100 cubic yards. The quality control plan shall include the Department's pre pour agenda information with a pre pour inspection checklist form for each major structural pour. Do not proceed with major concrete work until the quality control plan has been submitted and approved. Approval of the CQCP does not imply any warranty by the Department that the plan will result in consistent contract compliance. Be responsible to demonstrate such compliance. Deviations from the plan shall be approved in writing. Failure to comply with the quality control plan may result in work suspension. The CQCP shall include identification of sources and producers of all components used in the mix, aggregate production, informational quality control testing, delivery, placement, finish, and curing equipment and methods. Include personnel and their specific duties. Describe procedures to be followed in preparation of the pour, the event of equipment breakdown or inclement weather during placement, finishing, and curing. When pumping concrete for major structural pours, include, as part of the CQCP, a detailed plan addressing corrective measures to be taken to ensure in place concrete properties meet the specified requirements. Curing procedures shall include when and how the concrete and the curing system are to be placed, frequency for monitoring, maintaining, and re wetting the curing system. Include methods of protecting the covers from displacement from wind or weather, and method of preventing heat and moisture loss. In addition, describe the method to be used to protect pedestrian and vehicular traffic under structures. Designate a quality control supervisor who shall be responsible for the preparation, submittal, implementation, and oversight of the quality control plan. The quality control supervisor shall be an employee of the Contractor, under the direct supervision of the superintendent, solely dedicated to the Contract and shall not be responsible for other day to day operations on the project. The quality control supervisor shall have the authority to stop any and all work outlined in the quality control plan if the work is not properly performed. The quality control supervisor shall be available for contact 24 hours a day during the placement and cure of any concrete. The quality control supervisor shall be capable of being on site within 45 minutes of notification. The quality control supervisor shall perform and document a pre pour inspection 24 hours prior to the pour and at least 4 concrete inspections the day of the pour. The inspections shall be made before placement, during placement, when curing begins, and during curing. Inspect concrete forms, reinforcing steel adequately tied and supported, concrete quality control testing reports, fogging, and curing process and equipment. Submit a completed pre pour inspection checklist 24 hours prior to each major structural pour. Include these

quality control inspection reports in the weekly report and provide them within 24 hours of end of concrete placement, if requested. The quality control supervisor shall also perform and document at least 6 daily cure inspections during the required cure period for each bridge deck pour, at a maximum of 4 hours between inspections. The inspections shall be made at the beginning of primary shift, at approximate time of high temperature, at approximate time of low temperature, and at the end of primary shift. Prepare a daily inspection report which includes date and time of inspection, weather conditions, locations of bridge deck where curing was checked (at least 3 representative locations), moisture condition of deck and burlap, surface temperature of deck concrete, and condition of curing equipment. Include the daily cure inspection reports in the weekly report and provide them within 24 hours, if requested. The CQCP shall include performance of informational quality control testing by contractor personnel. Furnish personnel, laboratory, equipment, and materials needed to perform the required tests. Personnel, including the Quality Control Supervisor, shall require qualification as Western Alliance for Quality Transportation Construction (WAQTC) or Nevada Alliance for Quality Transportation Construction (NAQTC), as well as qualification as ACI Field Testing Certification, Grade I. Include test results in the weekly report and provide them within 24 hours of completion of each concrete pour, if requested. Material that does not meet contract requirements shall not be incorporated into the work. The quality control testing and required frequencies are as follows: CONCRETE AGGREGATES Test Test Method Minimum Sample Frequency Moisture Content Nev. T112 One per 100 yd3 or fraction thereof Sieve Analysis Nev. T206 One per 300 yd3 or fraction thereof Sand Equivalent Nev. T227 One per 300 yd3 or fraction thereof Cleanness Value Nev. T228 One per 300 yd3 or fraction thereof Specific Gravity and Absorption (Coarse) Nev. T492 One per 500 yd3 or fraction thereof Specific Gravity and Absorption (Fine) Nev. T493 One per 500 yd3 or fraction thereof PORTLAND CEMENT CONCRETE (Except Class S and SA) Test Test Method Minimum Sample Frequency Air Content Nev. T431 One per 50 yd3 or fraction thereof Unit Weight Nev. T435 One per 50 yd3 or fraction thereof Slump Nev. T438 One per 50 yd3 or fraction thereof CLASS S AND SA CONCRETE Test Test Method Minimum Sample Frequency Slump Flow Nev. T417 One per 50 yd3 or fraction thereof Visual Stability Index Nev. T417 One per 50 yd3 or fraction thereof J Ring Nev. T418 One per 50 yd3 or fraction thereof Unit Weight Nev. T416 One per 50 yd3 or fraction thereof Air Content Nev. T416 One per 50 yd3 or fraction thereof Sample concrete aggregates from each stockpile to be used in pour in accordance with Test Method No. Nev. T200. Sample Portland cement concrete in accordance with Test Method No. Nev. T425. Sample and perform all tests for Class S and SA concrete within the first two trucks for the first sample frequency. 501.02.04

Admixtures. Class S and SA concrete admixture systems shall conform to AASHTO M194 (ASTM C494) Type F or Type G, or ASTM C 1017 requirements. Include viscosity modifying admixtures (VMA) in the mix design. The mix design shall outline the dosage rate in oz/cwt. VMA's shall conform to ASTM C494, Type S. Adjust the dosage rate within the manufacturer's recommended range in order to obtain the desired flow and segregation characteristics while maintaining the required VSI. 501.02.05 Concrete Making Properties. Add the following to the table on the top of page 209 of the Standard Specifications: Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression ASTM C469 Permeability ASTM C1202 For Class S and SA concrete, the unit weight, air content, and compressive strength will be tested according to Test Method No. Nev. T416. Concrete used in bridge decks, approach slabs, and bridge deck rail shall have a maximum permeability of 2000 Coulombs at 56 days. The requirement for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression will be specified on the plans. In addition to meeting the requirements of this Subsection, Class S and SA concrete shall meet the additional following requirements: TEST TEST DESIGNATION REQUIREMENTS Slump Flow Nev. T417 (a) J Ring Nev. T418 (b) Column Static Segregation Nev. T420 Segregation Index 10% Max. (a) The slump flow shall be a single value between 18 and 28 inches and shall be shown on the mix design. The slump flow of the tested concrete shall be within ± 2 inches of the value specified on the mix design. The maximum Visual Stability Index shall not exceed 1. (b) The difference in slump flow values between Test Method No. Nev. T417 and Test Method No. Nev. T418 shall not exceed 2 inches. Add the following to item “9.” in the first paragraph on page 210 of the Standard Specifications: Not applicable for Class S and SA concrete, except for extended time slump requirements for concrete used in drilled shafts as specified in Subsection 509.02.01. Add the following to the first paragraph on page 210 of the Standard Specifications: 22. The permeability of concrete (if required). 23. The modulus of elasticity of concrete (if required). For Class S and SA concrete, add the following to the first paragraph on page 210 of the Standard Specifications: 24. The slump flow, visual stability index, j-ring measurement, and column static segregation index. 501.03.01 Equipment. For Class S and SA concrete, internal rodding or vibrating shall not be performed without prior approval. 501.03.06 Mixing. Prevent cement balling (intermittent clumping) and mix foaming by controlling the batch sequence, mixing speed, and mixing time. Segregated concrete, as determined by Test Method No. Nev. T417 or Test Method No. Nev. T418, shall not be incorporated into any component of the concrete work. For Class S and SA concrete, when delivering the concrete to the work site, completely discharge each delivery truck within 60 minutes. The discharge time can be extended to 90 minutes for drilled shafts. In hot weather, or under

minutes for drilled shafts. In hot weather, or under conditions contributing to quick stiffening of the concrete, a delivery time of less than 60 minutes may be required. The Contractor may propose delivery time exceeding 60 minutes if they can demonstrate during a trial pour that all required fresh concrete properties are maintained for the maximum proposed delivery time. The trial pour shall be completed in similar weather conditions to the anticipated placement conditions. For Class S and SA concrete, completely discharge each delivery truck within 20 minutes. Place the concrete in continuous layers. When it is necessary by reason of emergency or other delay to place less than a complete horizontal layer in one operation, terminate the layer by using a vertical bulkhead. Do not rod or vibrate the concrete to attempt to restore the fluidity to the mix. 501.03.10 Trial Slab and Process Control Testing. If silica fume is used in bridge deck concrete, construct a trial slab at least 30 days prior to placement of concrete on a bridge deck. Submit a written plan for the casting of the trial slab. The written plan shall include, but is not limited to, the location of the slab, the equipment and personnel used for construction, and disposal of the slab. Prior to placement of the trial slab, conduct a pre construction conference. Use approved mix designs. Place concrete at a location other than the bridge deck, but under conditions similar to those that exist during bridge deck concrete placement. The trial slab shall have a minimum length and width of 50 feet and have a depth of 8 inches. Reinforce slab with a top and bottom mat of # 5 bars spaced 6 inches longitudinally and transversely. Place top mat at a depth 2.5 inches from the top of the slab. Place bottom mat at a depth 1.5 inches from the bottom of the slab. The trial slab shall be wet cured as specified for bridge decks according to Subsection 501.03.08. Use personnel such as the superintendent, key operators, and finishers that are the same personnel who will be involved in the construction of the bridge deck. Demonstrate the use of equipment, proficiency of personnel, and techniques for mixing, transporting, placing, and curing of the concrete during the trial. Fifteen days after placement of the trial slab, conduct a post construction critique of the trial slab placement. Do not commence placement of the bridge deck concrete until after issues from the post construction critique of trial slab construction have been resolved to the satisfaction of the Engineer. Upon notification, remove and dispose of trial slabs according to Subsection 107.14. 501.05.01 Payment. Full compensation for construction and removal of trial slabs and trial pours shall be considered as included in the contract unit price paid for other appropriate items and no separate payment will be made therefore.

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
We require a minimum of 20% pozzolan by mass in all concrete. In lieu of the 20% minimum addition of pozzolan, slag cement will be permitted as a mineral admixture. Use a minimum of 35% slag cement. Class F pozzolan may be used in conjunction with slag cement at a rate of 15% by mass of the total cementitious material. The maximum total mineral admixture substitution shall be 50% of the mass of the total cementitious material. Silica fume may be used to replace 3% to 7%, by mass, of the total cementitious material.

Q4: Have you used fibers in bridge deck mixes?

No,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
We do have an upcoming project that will require fibers in the deck mix.

Q5: Have you used shrinkage reducing admixtures in bridge decks?

Yes,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
Currently, we require ASTM C157 with some modifications to meet 0.04%. In the past, we required 1.5 gal. per cubic yard of concrete. The shrinkage admixture was only required when a deck was built on steel girders.

Q6: Have you used lightweight aggregate in bridge deck mixes?

No,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
However, we do have a lightweight aggregate spec.

Q7: What are your curing requirements for bridge decks?

Bridge Deck Curing. Use Figure 4.1 from ACI 305R, Hot Weather Concreting, to determine the evaporation rate. Provide additional protection measures if the rate of evaporation exceeds 0.1 lb/ft3/hr. Provide accurate record of placement location air temperature, relative humidity, concrete temperature and wind velocity. Take readings an hour prior to the concrete placement and at fifteen minutes increments during concrete placement until the final curing blanket is placed. Submit required data as directed.

Monitor concrete temperature during the entire curing period by utilizing recording thermocouples embedded at 25 mm (1 in.) below the concrete surface and 25 mm (1 in.) above the bottom of the deck. A minimum of two sets of installations will be required per each days pour. The thermocouples shall be capable of recording the concrete temperature as a function of time and be accurate to within 1 °C (1.8 °F). Maintain a maximum temperature differential between the top and bottom thermocouples of 17 °C (30 °F). Submit the information gathered from the thermocouples.

Immediately after the concrete is finished, maintain the moisture content by continuously humidifying the air above the deck until the curing covers are placed. Use fogging equipment mounted on a finishing bridge which is separate from the concrete placing equipment.

Perform wet curing of the surface for 10 days, unless otherwise directed, using burlap conforming to Subsection 702.03.01, soaker hoses, and polyethylene conforming to ASTM C171.

Begin placing pre-soaked burlap within 30 minutes after the finishing is started. Place soaker hoses on the burlap to provide continuous wetting.

Cover the burlap and soaker with polyethylene. Lap polyethylene a minimum of 450 mm (18 in.) and seal the edges to prevent loss of heat and moisture.

Maintain the burlap in a wetted condition during the entire curing period. Water temperature shall be within 11 °C (20 °F) of the top of the bridge deck.

If the ambient temperature drops below 7 °C (45 °F) provide additional protection according to Subsection 501.03.09.

After the wet curing period, remove the wet curing materials and apply curing compound according to (a) Curing Compound Method. Maintain the moisture content of the surface of the deck until the curing compound is applied. The application rate of the bridge deck curing compound, at any point, shall be 0.30 ± 0.05 L/m2 (1 gal/135 ft2 ± 20 ft2). Equip power operated spraying equipment for application of curing compound with an operational pressure gage and means of controlling the pressure.

Q8: Do you have smoothness requirements for bridge decks?

If yes, what criteria do you use and how is it measured.
There shall be a minimum 2 profiles per lane, each 1 m (3 ft) from the lane lines and one profile for each shoulder approximately 1 m (3 ft) from the curb or rail face. All profilograph runs shall be made in a direction parallel to and in the direction of traffic. In addition, when a straightedge 3.6 m (12 ft) long is laid on the finished surface at right angles to the centerline and extending from edge to edge of traffic lane, the surface shall not vary more than 3 mm (0.01 ft) from the lower edge of the straight edge. When a straightedge 3.6 m (12 ft) long is laid on the finished surface parallel with the centerline of the bridge deck and approach slabs, the surface shall not vary more than 3 mm (0.01 ft) from the lower edge of the straightedge.

Q9: Do you typically grind bridge decks?

For what reason? Smoothness, Noise, Other?
Smoothness

Q10: Do you seal bridge decks?

Additional Comments
Bridge decks are sealed for rehabilitation only.

Q11: What type of sealers do you allow/specify?

Methylmethacrylate	Allow
Additional Comments?	We also allow multilayer and polyester overlays.

Q12: What is the application rate for each sealer?

Methylmethacrylate	Specify
Additional Comments?	Methylmethacrylate 0.09 gal. per square yard Polyester overlay 3/4" thick Multilayer 3/8" thick

Q13: What is the typical performance life of a sealed joint?

8 to 10 years

Q14: If you seal bridge decks, how often do you retreat?

If Yes, what is it? Does your Agency retreat or do you let a Contract for the work?
Contract Methylmethacrylate - NA Polyester overlay - 10 years Multilayer 3/8" thick - Unknown, no experience of life

Q15: Please attach a link to approved products list and approval process for joint sealants.

http://www.nevadadot.com/About_NDOT/NDOT_Divisions/Planning/Research/Qualified_Products_List.aspx
502.03.13b PREFORMED JOINT FILLERS

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.

Respondent skipped this question

Q17: Any additional comments?

Respondent skipped this question

#4

COMPLETE

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PAGE 1

Q1: State Representative

Name	Donald Streeter
Agency	NYSDOT
State / Province	New York
Email	donald.streeter@dot.ny.gov

Q2: Do you a high performance bridge deck mix specification?

If yes, what are the mix design requirements?
prescriptive mix that includes 500# cement 135# pozzolan (F ash or GGBFS typically) 40# silica fume 0.40 w/c ratio 40% sand (as % of total agg content) 5% - 8% air 3/4" nominal max coarse agg

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
20% pozzolan (fly ash or GGBFS) and 6% silica fume are required.

Q4: Have you used fibers in bridge deck mixes?

No

Q5: Have you used shrinkage reducing admixtures in bridge decks?

No

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
light weight coarse aggs used for light weight concrete to reduce dead load. light weight fine aggs used for internal curing

Q7: What are your curing requirements for bridge decks?

14 days continuous wetting

Q8: Do you have smoothness requirements for bridge decks?

No

Q9: Do you typically grind bridge decks?

For what reason? Smoothness, Noise, Other?
some decks have had diamond grinding for noise, others to address staged construction issues that have poor transition between stages

Q10: Do you seal bridge decks?	Yes

Q11: What type of sealers do you allow/specify?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Allow
Additional Comments?	penetrating sealer (silane or siloxane) required on all new decks prior to first winter's salting at rate of 150 sf .gal. Methacrylates used for crack repairs as necessary applied using squeeze bottle to refusal. Methacrylates also used by Maintenance Forces for preventive maintenance, coverage as per manufacturer recommendations and/or as necessary to fill cracks / grooving, etc... and adhere friction aggregates. Polymer modified overlays rare but have been used.

Q12: What is the application rate for each sealer?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow
Polymer Modified Overlay	Allow
Additional Comments?	see above for application rates

Q13: What is the typical performance life of a sealed joint?

pavement or bridge?

Q14: If you seal bridge decks, how often do you retreat?	If Yes, what is it? Does your Agency retreat or do you let a Contract for the work? maintenance program to reseal with penetrating sealers is on 7 year cycle.

Q15: Please attach a link to approved products list and approval process for joint sealants.

https://www.dot.ny.gov/divisions/engineering/technical-services/materials-bureau/materials-and-equipment

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.	If Yes, what is it? Section 583 of standard specification found at https://www.dot.ny.gov/main/business-center/engineering/specifications/english-spec-repository/2016_5_Specs_USC_tc.pdf
Q17: Any additional comments?	*Respondent skipped this question*

#12

COMPLETE

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PAGE 1

Q1: **State Representative**

Name	Clayton Schumaker
Agency	North Dakota DOT
State / Province	North Dakota
Email	cschumaker@nd.gov

Q2: **Do you a high performance bridge deck mix specification?**

No

Q3: **Do you allow supplementary cementitious materials in bridge deck mixes?**

Yes,

If yes, what types? What percentage? Please be as specific as you can.
allow up to 29 percent fly ash replacement of cement by weight. You can use up to 10 percent fly ash and deck has to be wet cured for 7 days. Anything greater than 10 percent and less than 29 percent fly ash requires 10 days wet cure.

Q4: **Have you used fibers in bridge deck mixes?**

No

Q5: **Have you used shrinkage reducing admixtures in bridge decks?**

No

Q6: **Have you used lightweight aggregate in bridge deck mixes?**

No

Q7: **What are your curing requirements for bridge decks?**

Seven days wet cure.

Q8: **Do you have smoothness requirements for bridge decks?**

No

Q9: **Do you typically grind bridge decks?**

No

Q10: **Do you seal bridge decks?**

Yes

Q11: What type of sealers do you allow/specify?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Do not use
Epoxy Chip Seal	Do not use
Polymer Modified Overlay	Do not use

Q12: What is the application rate for each sealer?

Silane	Allow
Siloxane	Allow
Additional Comments?	Manufacture's recommendation

Q13: What is the typical performance life of a sealed joint?

10 years

Q14: If you seal bridge decks, how often do you retreat? No

Q15: Please attach a link to approved products list and approval process for joint sealants. *Respondent skipped this question*

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification. No

Q17: Any additional comments? *Respondent skipped this question*

#23

COMPLETE

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PAGE 1

Q1: State Representative

Name	Dan Miller
Agency	Ohio Department of Transportation
State / Province	Ohio
Email	daniel.miller@dot.ohio.gov

Q2: Do you a high performance bridge deck mix specification?

No

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
Fly Ash- 25% Slag- 30% Micro Silica- 10% Total combination of supplementary cementitious materials cannot exceed 50% of cementitious materials by weight.

Q4: Have you used fibers in bridge deck mixes?

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
Some Districts use a plan note requiring 2 lb/cy of polypropylene fibers 3/4" minimum length. We are looking at the possibility of macro fibers in bridge deck mixes.

Q5: Have you used shrinkage reducing admixtures in bridge decks?

No,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
Note: We currently do not allow "Type S" admixtures unless they are specified by a plan note.

Q6: Have you used lightweight aggregate in bridge deck mixes?	Yes, If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can. Lightweight fine aggregate has been used in bridge decks to reduce bridge deck cracking and was resulted in research (Delatte, Mack, Cleary, FHWA/OH-2007/06). Current lightweight mixes being used contain lightweight coarse aggregate (635# of 3/4" aggregate per cy)

Q7: What are your curing requirements for bridge decks?

Method A: Water curing for 7 days using double layer of wet burlap with continuous flow of water OR wet burlap with white polyethylene sheeting or plastic coated burlap blankets.

Method B: After curing the top surface for 7 days remove burlap and standing water. Within 12 hours after removing the burlap, apply a curing membrane at a rate of 200 square feet per gallon.

Q8: Do you have smoothness requirements for bridge decks?	If yes, what criteria do you use and how is it measured. Proposal Note 555 addresses bridge deck smoothness. http://www.dot.state.oh.us/Divisions/ConstructionMgt/Specification%20Files/PN555_04172015_for_2016.PDF
Q9: Do you typically grind bridge decks?	For what reason? Smoothness, Noise, Other? Meet the PN 555 requirements http://www.dot.state.oh.us/Divisions/ConstructionMgt/Specification%20Files/PN555_04172015_for_2016.PDF
Q10: Do you seal bridge decks?	Yes

Q11: What type of sealers do you allow/specify?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Specify
Epoxy Chip Seal	Do not use
Polymer Modified Overlay	Do not use

Q12: What is the application rate for each sealer?

Additional Comments?	Application rate is per the manufacturer's recommendations.

Q13: What is the typical performance life of a sealed joint?

5 years due to damage from snow plows and freeze thaw cycles.

Q14: If you seal bridge decks, how often do you retreat?	If Yes, what is it? Does your Agency retreat or do you let a Contract for the work? unknown, this would be handled at the District offices by the maintenance forces.

Q15: Please attach a link to approved products list and approval process for joint sealants.

http://www.dot.state.oh.us/Divisions/ConstructionMgt/Materials/Pages/QPL.aspx#joint

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.

No

Q17: Any additional comments?

Respondent skipped this question

#13

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Wednesday, March 23, 2016 10:29:08 AM
Last Modified: Wednesday, March 23, 2016 10:44:53 AM
Time Spent: 00:15:45
IP Address: 204.62.25.101

PAGE 1

Q1: State Representative

Name	Matt Romero
Agency	ODOT
State / Province	Oklahoma
Email	mromero@odot.org

Q2: Do you a high performance bridge deck mix specification?

No

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
Primarily type C flyash

Q4: Have you used fibers in bridge deck mixes?

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
Only once on an experimental bridge project on I-40 at mile post 25. We have also used fiber (Steel and/or polypropylene) in bridge deck overlays.

Q5: Have you used shrinkage reducing admixtures in bridge decks?

Yes,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
Only once on an experimental bridge project on I-40 at mile post 25.

Q6: Have you used lightweight aggregate in bridge deck mixes?

No

Q7: What are your curing requirements for bridge decks?

Water cure for 7 days then curing compound.

Q8: Do you have smoothness requirements for bridge decks?

If yes, what criteria do you use and how is it measured.
When the ride spec is required for bridge decks, we measure with profilograph.

Q9: **Do you typically grind bridge decks?**	For what reason? Smoothness, Noise, Other? We grind for ride requirements or we may grind for tinning.
Q10: **Do you seal bridge decks?**	Additional Comments We use HMWM or low viscosity epoxy.

Q11: **What type of sealers do you allow/specify?**

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow
Polymer Modified Overlay	Allow

Q12: What is the application rate for each sealer?	*Respondent skipped this question*

Q13: **What is the typical performance life of a sealed joint?**

Based on research conducted for us by Oklahoma State university for silanes, we have no failures at 12 years, 32% failure at 15 years and 84% failures at more than 17-20 years.

Q14: **If you seal bridge decks, how often do you retreat?**	If Yes, what is it? Does your Agency retreat or do you let a Contract for the work? We have resealed a handful of post-tensioned bridge decks.

Q15: **Please attach a link to approved products list and approval process for joint sealants.**

http://www.odot.org/materials/htm-smap/11062p-PRODCATS.html

Q16: **Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.**	If Yes, what is it? Section 521 of the 2009 Oklahoma Standard Specifications for Highway Construction. http://www.odot.org/c_manuals/specbook/oe_ss_2009.pdf

Q17: **Any additional comments?**

None.

#1 COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, March 01, 2016 6:05:26 AM
Last Modified: Tuesday, March 01, 2016 7:16:44 AM
Time Spent: 01:11:18
IP Address: 63.66.64.247

PAGE 1

Q1: State Representative

Name	Neal Fannin
Agency	PennDOT
State / Province	PA
Email	nfannin@pa.gov

Q2: Do you a high performance bridge deck mix specification?

If yes, what are the mix design requirements?
4000 psi Comp Str. 2000 Coulombs at 56 days by AASHTO T 277 during mix design 500 microstrain at 28 days by ASTM C157 during mix design 7% air +/- 1.5% during design and placement. Max cementitious 690 (being lowered to 640 soon) Use of shilstone for optimized aggregate. 14 day wet cure. followed by 7 day plastic or white membraine curing.

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
GGBFS Fly ash silica fume ASR mitigation currently required for all mixes pending implementation of AASHTO

Q4: Have you used fibers in bridge deck mixes?

No

Q5: Have you used shrinkage reducing admixtures in bridge decks?

No

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
Structural capacity of rehab projects

Q7: What are your curing requirements for bridge decks?

14 day wet cure. followed by 7 day plastic or white membrane curing.

Q8: Do you have smoothness requirements for bridge decks?

No

Q9: Do you typically grind bridge decks?

No

Q10: Do you seal bridge decks?	Additional Comments Allowed at District discretion

Q11: What type of sealers do you allow/specify?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Allow

Q12: What is the application rate for each sealer?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Allow
Additional Comments?	Silane, Siloxane, Methylmethacrylate - Generally allowed at District discretion. Applied at manufacturers recommended rate. Not mandated. Epoxy Chip Seal - 2 coats Polymer / latex overlay -1.25 in. to 2+ inches.

Q13: What is the typical performance life of a sealed joint?

5 to 10 years ????

Q14: If you seal bridge decks, how often do you retreat?	No

Q15: Please attach a link to approved products list and approval process for joint sealants.

http://www.dot.state.pa.us/public/pdf/BOCM_MTD_LAB/PUBLICATIONS/PUB_35/Current_Edition/Bulletin15.pdf
Then search for 1019.2(b)

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.	If Yes, what is it? http://www.dot.state.pa.us/public/PubsForms/Publications/Pub_408/408_2016/408_2016_IE/408_2016_IE.pdf Then go to section 1043
Q17: Any additional comments?	*Respondent skipped this question*

#26

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, April 08, 2016 8:59:29 AM
Last Modified: Friday, April 08, 2016 9:49:43 AM
Time Spent: 00:50:13
IP Address: 158.123.9.95

PAGE 1

Q1: State Representative

Name	Christopher Hart
Agency	RIDOT
State / Province	RI
Email	christopher.hart@dot.ri.gov

Q2: Do you a high performance bridge deck mix specification?

If yes, what are the mix design requirements?
Our high performance mix is not exclusively for bridge decks. Cementitious Content: 500-700 lbs/CY Maximum w/c: 0.40 Strength: 5000 PSI @ 28-days Air Content: 5%-9% Slump: 2"-4" (up to 9" w/super plasticizer) Chloride Permeability (AASHTO T277): ≤ 2000 c @ 28-days Shrinkage (AASHTO T160): <-0.040% @ 28-days

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
Fly Ash: <15% (not currently in use) Silica Fume: 7% Slag: % not specified (current mixes using 25%-40%)

Q4: Have you used fibers in bridge deck mixes?

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
Propex Fibermesh Grace Fibers 1 lb/CY

Q5: Have you used shrinkage reducing admixtures in bridge decks?

Yes,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
Used in the past. No longer use due to problems controlling entrained air.

Q6: Have you used lightweight aggregate in bridge deck mixes?

No

Q7: What are your curing requirements for bridge decks?

14-day wet cure period and attaining 28-day strength
Wet burlap, soaker hoses and poly sheeting cover for duration of curing period

Q8: Do you have smoothness requirements for bridge decks?	If yes, what criteria do you use and how is it measured. <1/8" variance in 10 feet 10 foot straight edge
Q9: Do you typically grind bridge decks?	For what reason? Smoothness, Noise, Other? All exposed concrete bridge decks are ground for smoothness and noise. Overlaid bridge decks are not typically ground.
Q10: Do you seal bridge decks?	It depends

Q11: What type of sealers do you allow/specify?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Allow

Q12: What is the application rate for each sealer?

Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Allow
Additional Comments?	When sealer used application rate is per the manufacturer's recommendations.

Q13: What is the typical performance life of a sealed joint?	*Respondent skipped this question*
Q14: If you seal bridge decks, how often do you retreat?	No

Q15: Please attach a link to approved products list and approval process for joint sealants.

http://www.dot.ri.gov/business/approved_materials.php

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.	If Yes, what is it? Section 817 http://www.dot.ri.gov/business/bluebook.php
Q17: Any additional comments?	*Respondent skipped this question*

#11

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Friday, March 18, 2016 1:48:42 PM
Last Modified: Friday, March 18, 2016 2:47:35 PM
Time Spent: 00:58:52
IP Address: 164.154.156.59

PAGE 1

Q1: **State Representative**

Name	Darin Hodges
Agency	SDDOT
State / Province	SD
Email	darin.hodges@state.sd.us

Q2: **Do you a high performance bridge deck mix specification?**

No

Q3: **Do you allow supplementary cementitious materials in bridge deck mixes?**

Yes,

If yes, what types? What percentage? Please be as specific as you can.
We specify 20% Class F Modified Fly Ash in all our bridge deck mixes.

Q4: **Have you used fibers in bridge deck mixes?**

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
SDDOT did some research with the Polyolefin 3M fibers where deck overlays and a whole deck where cast at 25lbs/yd3. This was over 15 years ago and they all performed better than expected. Now we are doing some select deck overlays with a Strux 90/40 or equal at 8 lb/yd3.

Q5: **Have you used shrinkage reducing admixtures in bridge decks?**

No

Q6: **Have you used lightweight aggregate in bridge deck mixes?**

No

Q7: **What are your curing requirements for bridge decks?**

Fog immediately after finishing. Then within 25' of finish machine cover with wet burlap and keep it wet, once workers can walk on the concrete add soaker hoses and cover with blankets. Continue wet cure for 7 days.

Q8: **Do you have smoothness requirements for bridge decks?**

If yes, what criteria do you use and how is it measured.
1/8" by 10 foot straight edge.

Q9: **Do you typically grind bridge decks?**	For what reason? Smoothness, Noise, Other? Yes, occasionally for smoothness. We also diamond grind a bridge deck before an epoxy chip seal is performed.
Q10: **Do you seal bridge decks?**	Yes

Q11: **What type of sealers do you allow/specify?**

Silane	Specify
Siloxane	Specify
Epoxy Chip Seal	Specify

Q12: **What is the application rate for each sealer?**

Silane	Specify
Siloxane	Specify
Epoxy Chip Seal	Specify
Additional Comments?	Silane / Siloxane - At manufacturers recommendations. Epoxy Chip Seal - A coat of epoxy shall be distributed at the manufacturer's recommended application rate. The application rate shall be a minimum of 1 gallon per 40 square feet. Two coats must be applied.

Q13: What is the typical performance life of a sealed joint?	*Respondent skipped this question*
Q14: If you seal bridge decks, how often do you retreat?	*Respondent skipped this question*

Q15: **Please attach a link to approved products list and approval process for joint sealants.**

http://www.sddot.com/business/certification/Default.aspx

Q16: **Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.**	No
Q17: Any additional comments?	*Respondent skipped this question*

#25

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, April 04, 2016 2:45:54 PM
Last Modified: Tuesday, April 05, 2016 1:15:57 PM
Time Spent: 22:30:03
IP Address: 170.141.177.61

PAGE 1

Q1: State Representative

Name	Jamie Waller
Agency	Tennessee Department of Transportation
State / Province	Tennessee
Email	jamie.waller@tn.gov

Q2: Do you a high performance bridge deck mix specification?

No

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
Fly ash - Both F and C ash at 25% max replacement of cement. Slag - Grade 100 or 120 at 35% maximum replacement rate of cement. Ternary mixtures (cement, fly ash, and slag) - Minimum 50% cement, maximum 20% fly ash, remainder is slag.

Q4: Have you used fibers in bridge deck mixes?

No

Q5: Have you used shrinkage reducing admixtures in bridge decks?

No

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
Lightweight aggregates were used as part of research projects and to reduce loads on bridges.

Q7: What are your curing requirements for bridge decks?

Curing requirements for bridge decks include a 5 day wet cure. Immediately apply liquid membrane curing compound as soon as possible after placement followed by burlap kept moist by soaker hose or sprinkler.

Q8: **Do you have smoothness requirements for bridge decks?**	If yes, what criteria do you use and how is it measured. 604.27 B Smoothness Testing: After the bridge decks, approach slabs, and roadway pavement tie-ins are completed, the Department will conduct smoothness tests using the Rainhart Profilograph or high speed road profiler output converted to a profile index in each wheel path beginning and ending 300 feet past each end of the bridge unless a shorter distance is specified by the Engineer or shown on the Plans. Where the roadway approaches to the bridge are not paved with hot mix asphalt or Portland cement concrete under this Contract, smoothness testing will be performed only on the bridge deck and approach slabs. Schedule profile testing at least 7 days prior to need. Clean and clear the area to be tested of all obstructions. Wheel paths will be located 3 feet each side of the centerline of each traffic lane. Each lane for the length of the bridge and approaches (maximum 300 feet beyond each end of the bridge) shall be considered one lot. Using a 0.1-inch blanking band, the pavement roughness index for each lot shall not exceed the maximum allowable Pavement Roughness Index values specified Table 604.27-1. Table 604.27-1: Pavement Roughness Index Bridge Profile Index Lot Distance Profile Index Values (feet) (inch/mile) 100 to 200 19.5 201 to 300 18.5 301 to 400 18.0 401 to 600 17.5 601 to 800 17.0 801 to 1000 16.5 1001 to 1500 16.0 1501 to 2000 15.5 2001 to 3000 15.0 3001 to 4000 14.5 Over 4001 14.0 In addition, all areas of pavement roughness index using a 0.1-inch blanking band represented by high points having deviations in excess of 0.4 inch for any 25-foot section per each wheel path shall be corrected.
Q9: **Do you typically grind bridge decks?**	It depends
Q10: **Do you seal bridge decks?**	It depends
Q11: **What type of sealers do you allow/specify?**	
Silane	Allow
Siloxane	Allow
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Allow

Q12: What is the application rate for each sealer?

Silane	Specify
Siloxane	Specify
Methylmethacrylate	Specify
Epoxy Chip Seal	Specify
Polymer Modified Overlay	Specify
Additional Comments?	Manufacturers recommended dosage rates

Q13: What is the typical performance life of a sealed joint?

Approximately 5 years of service life.

Q14: If you seal bridge decks, how often do you retreat? No

Q15: Please attach a link to approved products list and approval process for joint sealants.

TDOT Approved Qualified Products List
http://www.tn.gov/tdot/topic/tdot-materialstests-research-product-evaluation-qualified-products

Approval Process for Joint Sealants - Specification 905.05
http://www.tn.gov/assets/entities/tdot/attachments/TDOT_2015_Spec_Book_FINAL_pdf.pdf

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.

If Yes, what is it?
TDOT Standard Specifications 2015: Specifications 622 - Shotcrete
http://www.tn.gov/assets/entities/tdot/attachments/TDOT_2015_Spec_Book_FINAL_pdf.pdf

Q17: Any additional comments?

Respondent skipped this question

#6

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Tuesday, March 15, 2016 11:27:50 AM
Last Modified: Tuesday, March 15, 2016 2:59:27 PM
Time Spent: 03:31:37
IP Address: 168.178.122.38

PAGE 1

Q1: **State Representative**

Name	Bryan Lee
Agency	UDOT
State / Province	Utah
Email	bryanlee@utah.gov

Q2: **Do you a high performance bridge deck mix specification?**

If yes, what are the mix design requirements?
Current special provision requires a combined gradation that falls within the parallelogram of a typical coarseness factor graph. Currently a .44 w/cm ratio is a maximum. Considering a .40 maximum f'c at 4000 psi Shrinkage requirements per modified C 157 at 0.042 at 28 days. Considering a limit of 0.030 Considering the required use of micro fibers at 1 lb/cy and macro fibers at 5 lbs/cy

Q3: **Do you allow supplementary cementitious materials in bridge deck mixes?**

Yes,

If yes, what types? What percentage? Please be as specific as you can.
Class F fly ash Natural Pozzolan (class N) - Seldom Used Silica Fume - Seldom Used Maximum total 30% pozzolan, minimum if SCM's are used must be 20% All SCM's must be pre-qualified by the Department

Q4: **Have you used fibers in bridge deck mixes?**

It depends,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
Considering the required use of micro fibers at 1 lb/cy and macro fibers at 5 lbs/cy

Q5: **Have you used shrinkage reducing admixtures in bridge decks?**

No

Q6: **Have you used lightweight aggregate in bridge deck mixes?**	Yes, If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can. Both internal curing and reduced load on the bridge. For reduced load: Keep the equilibrium density of the mix between 110 to 115 lb/ ft3 as determined according to ASTM C 567. Do not allow the unit weight of the fresh concrete to vary more than ± 4 lb/ft3 from the target density for fresh concrete established by the mix design for field acceptance. For internal curing: Determine the proportions of the internally cured concrete mix by modifying the proportions of the conventional normal weight concrete mix by replacing an equal volume of normal weight fine aggregate with the volume of prewetted light weight aggregate computed as follows: WLWA=0.07 (total weight of cementitious material) (1 + absorption)/((absorption)(desorption)). Where: Weight of prewetted light weight aggregate (WLWA), total cementitious material is expressed in lbs, absorption and desorption values are expressed as a decimal fraction and are to be provided by the lightweight aggregate supplier for the specific source.

Q7: **What are your curing requirements for bridge decks?**

Wet cure 14 days AND liquid membrane curing compound that meets ASTM C309, Type I D, Class A applied at the Manufacturer's recommended rate

Q8: **Do you have smoothness requirements for bridge decks?**	If yes, what criteria do you use and how is it measured. Grind concrete bridge deck surface until both sides of all joints are in the same plane and the entire surface, including the sleeper slab to roadway interface, meets the smoothness tolerances for Portland Cement Concrete Pavement (PCCP) according Smoothness specification
Q9: **Do you typically grind bridge decks?**	For what reason? Smoothness, Noise, Other? Smoothness as noted above.
Q10: **Do you seal bridge decks?**	Yes

Q11: **What type of sealers do you allow/specify?**

Silane	Do not use
Siloxane	Do not use
Methylmethacrylate	Allow
Polymer Modified Overlay	Allow

Q12: **What is the application rate for each sealer?**

Additional Comments?	Manufacturer's recommendations

Q13: What is the typical performance life of a sealed joint?	*Respondent skipped this question*
Q14: **If you seal bridge decks, how often do you retreat?**	If Yes, what is it? Does your Agency retreat or do you let a Contract for the work? Retreat as needed. Typically contractor work.

Q15: **Please attach a link to approved products list and approval process for joint sealants.**

http://www.udot.utah.gov/main/uconowner.gf?n=7597502676881542

Q16: **Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.**	If Yes, what is it? Special Provision. Document can be provided.
Q17: Any additional comments?	*Respondent skipped this question*

#19

COMPLETE

Collector: Web Link 1 (Web Link)
Started: Monday, April 04, 2016 1:32:54 PM
Last Modified: Monday, April 04, 2016 2:54:48 PM
Time Spent: 01:21:53
IP Address: 164.110.166.75

PAGE 1

Q1: State Representative

Name	DeWayne Wilson
Agency	Washington State DOT
State / Province	Washington
Email	wilsond@wsdot.wa.gov

Q2: Do you a high performance bridge deck mix specification?

If yes, what are the mix design requirements? 6-02.3(2)A1 Contractor Mix Design for Concrete Class 4000D All Class 4000D concrete shall conform to the following requirements: 1. Aggregate shall use combined gradation in accordance with Section 9-03.1(5) with a nominal maximum aggregate size of 1½ inches. 2. Permeability shall be less than 2,000 coulombs at 56 days in accordance with AASHTO T277. 3. Freeze-thaw durability shall be provided by one of the following methods: a. The concrete shall maintain an air content between 4.5 and 7.5 percent. b. The concrete shall maintain a minimum air content that achieves a durability factor of 90 percent, minimum, after 300 cycles in accordance with AASHTO T 161, Procedure A. This air content shall not be less than 3.0 percent. Test samples shall be obtained from concrete batches of a minimum of 3.0 cubic yards. 4. Scaling shall have a visual rating less than or equal to 2 after 50 cycles in accordance with ASTM C672. 5. Shrinkage at 28 days shall be less than 0.032 percent in accordance with AASHTO T 160. 6. Modulus of elasticity shall be measured in accordance with ASTM C469. 7. Density shall be measured in accordance with ASTM C138. The Contractor shall submit the mix design in accordance with Section 6-02.3(2)A. The submittal shall include test reports for all tests listed above that follow the reporting requirements of the AASHTO/ASTM procedures. Samples for testing may be obtained from either laboratory or concrete plant batches. If concrete plant batches are used, the minimum batch size shall be 3.0 cubic yards. The Contractor shall submit the mix design to the Engineer at least 30 calendar days prior to the placement of concrete in the bridge deck. http://www.wsdot.wa.gov/publications/manuals/fulltext/M41-10/SS2016.pdf

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can.
It is up to the Contractor and the concrete producer to determine the percentages when they develop their concrete mix design. With the Engineer's written concurrence, microsilica fume and metakaolin can be used in all classifications of Class 4000, Class 3000, and commercial concrete and is limited to a maximum of 10 percent of the cementitious material. As an alternative to the use of fly ash, ground granulated blast furnace slag and cement as separate components, a blended hydraulic cement that meets the requirements of Section 9-01.2(4) Blended Hydraulic Cements may be used.
http://www.wsdot.wa.gov/publications/manuals/fulltext/M41-10/SS2016.pdf

Q4: Have you used fibers in bridge deck mixes?

No

Q5: Have you used shrinkage reducing admixtures in bridge decks?

Yes,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
Depends on Contractor's mix design. Typical range 120-140 oz/CY. It appears it is helping to reduce cracking in new WSDOT bridges.

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
What purpose - Used on older bridges to replace an existing lightweight concrete deck. Not sure on the mix design used, would need to do a records search.

Q7: What are your curing requirements for bridge decks?

6-02.3(11)B Curing Bridge Deck
6-02.3(11)B1 Equipment
The Contractor shall maintain a wet sheen, without developing pooling or sheeting water, using a fogging apparatus consisting of pressure washers with a minimum nozzle output of 1,500 psi, or other means accepted by the Engineer.
The Contractor shall submit a Type 2 Working Drawing consisting of the bridge deck curing plan a minimum 14 calendar days prior to the pre-concreting conference.
The Contractor's plan shall describe the sequence and timing that will be used to fog the bridge deck, apply pre-soaked burlap, install soaker hoses and cover the deck with white reflective sheeting.
6-02.3(11)B2 Curing
The fogging apparatus shall be in place and charged for fogging prior to beginning concrete placement for the bridge deck.
The Contractor shall presoak all burlap to be used to cover the deck during curing.
Immediately after the finishing machine passes over finished concrete, the Contractor shall implement the following tasks:
1. The Contractor shall fog the bridge deck while maintaining a wet sheen without developing pooling or sheeting water.
2. The Contractor shall apply the presoaked burlap to the top surface to fully cover the deck without damaging the finish, other than minor marring of the concrete surface.
The Contractor shall not apply curing compound.3. The Contractor shall continue to keep the burlap wet by fog spraying until the burlap is
covered by soaker hoses and white reflective sheeting. The Contractor shall place the soaker hoses and white reflective sheeting after the concrete has achieved initial set. The Contractor shall charge the soaker hoses frequently so as to keep the burlap covering the entire deck wet during the course of curing.
As an alternative to tasks 2 and 3 above, the Contractor may propose a curing system using proprietary curing blankets specifically manufactured for bridge deck curing.
The Contractor shall submit a Type 2 Working Drawing consisting of details of the proprietary curing blanket system, including product literature and details of how the system is to be installed and maintained.
The wet curing regime as described shall remain in place for at least 14 consecutive calendar days.
http://www.wsdot.wa.gov/publications/manuals/fulltext/M41-10/SS2016.pdf

Q8: Do you have smoothness requirements for bridge decks?

If yes, what criteria do you use and how is it measured.
After floating, but while the concrete remains plastic, the Contractor shall test the entire deck/slab for flatness (allowing for crown, camber, and vertical curvature). The testing shall be done with a 10-foot straightedge held on the surface. The straightedge shall be advanced in successive positions parallel to the centerline, moving not more than one half the length of the straightedge each time it advances. This procedure shall be repeated with the straightedge held perpendicular to the centerline. An acceptable surface shall be one free from deviations of more than ⅛-inch under the 10-foot straightedge.

Q9: Do you typically grind bridge decks?

For what reason? Smoothness, Noise, Other?
We do not typically grind existing bridge decks. The new SR520 Floating bridge deck was ground to provide a smooth riding surface.

Q10: Do you seal bridge decks?

No

Q11: What type of sealers do you allow/specify? *Respondent skipped this question*

Q12: What is the application rate for each sealer? *Respondent skipped this question*

Q13: What is the typical performance life of a sealed joint?

Depends on the Joint type and materials. Typical life is about 15-20 years.

Q14: If you seal bridge decks, how often do you retreat? *Respondent skipped this question*

Q15: Please attach a link to approved products list and approval process for joint sealants.

Must meet this spec.
9-04.1(4) Elastomeric Expansion Joint Seals
Premolded elastomeric expansion joint seals shall conform to the requirements of ASTM D2628 and shall be formed by an extrusion process with uniform dimensions and smooth exterior surfaces. The cross-section of the seal shall be shaped to allow adequate compressed width of the seal, as approved by the Engineer.
9-04.2 Joint Sealants
9-04.2(1) Hot Poured Joint Sealants
Hot poured joint sealants shall meet the requirements of ASTM D6690 Type IV, except for the following:
1. The Cone Penetration at 25°C shall be 130 maximum.
2. The extension for the Bond, non-immersed, shall be 100 percent.
3. The hot poured joint sealant shall have a minimum Cleveland Open Cup Flash Point of 205°C in accordance with AASHTO T 48.
Hot poured joint sealants shall be sampled in accordance with ASTM D5167 and tested in accordance with ASTM D5329.
9-04.2(2) Poured Rubber Joint Sealer
The physical properties of the joint sealer, when mixed in accordance with the manufacturer's recommendations, shall be as follows:
1. Color: Gray or black.
2.1 Viscosity: Must be pourable and self-leveling at 50°F.
3.1 Application Life: Not less than 3 hours at 72°F and 50 percent relative humidity.
4. Set to Touch: Not more than 24 hours at 72°F and 50 percent relative humidity.
5. Curing Time: Not more than 96 hours at 72°F and 50 percent relative humidity.
6. Non-Volatile Content: Not less than 92 percent.
7. Hardness Rating (Durometer "Shore A"): 5-35.
8. Resiliency: Not less than 80 percent.
9. Bond test methods shall be in accordance with ASTM D5329.

Standard Specification: 9-04.2(1)

Product Name Spec Title Manufacturer
Roadsaver 520 Joint Seal - Hot Poured Joint Sealants Crafco, Inc., Chandler-AZ
RoadSaver 231 Joint Seal - Hot Poured Joint Sealants Crafco, Inc., Chandler-AZ
Beram 195 LM Joint Seal - Hot Poured Joint Sealants McAsphalt Industries LTD, Toronto-ON

http://www.wsdot.wa.gov/biz/mats/QPL/QPLProductsGrid.cfm
Standard Specification: 9-04.2(2)

Product Name Spec Title Manufacturer
Sikaflex-2C SL Joint Seal - Poured Rubber Joint Sealer Sika Corporation, Lyndhurst-NJ

Q16: **Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.**	If Yes, what is it? 6-18.3(2) Mix Design Shotcrete shall be proportioned to produce a 4,000 psi compressive strength at 28 days. Admixture shall be used only after receiving permission from the Engineer. If admixtures are used to entrain air, to reduce water-cement ratio, to retard or accelerate setting time, or to accelerate the development of strength, the admixtures shall be used at the rate specified by the manufacturer. http://www.wsdot.wa.gov/publications/manuals/fulltext/M41-10/SS2016.pdf
Q17: Any additional comments?	*Respondent skipped this question*

#20

COMPLETE

Collector: Web Link 1 (Web Link)
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Q1: **State Representative**

Name	Michael Mance
Agency	West Virginia DOH
State / Province	WV
Email	mike.a.mance@wv.gov

Q2: **Do you a high performance bridge deck mix specification?**

If yes, what are the mix design requirements?
Prescriptive cementitious material content requirement. Two options: Option 1: 2.39 cubic feet of cement, 0.84 cf of fly ash, 30 lb of silica fume Option 2: 2.15 cf of cement, 1.08 cf of slag cement, 30 lb of silica fume 4,000 psi at 28 days (never an issue) max w/c of 0.40 6.5% air permeability requirement of 750 coulombs or less at 56 to 90 days for mix design qualification.

Q3: **Do you allow supplementary cementitious materials in bridge deck mixes?**

Yes,

If yes, what types? What percentage? Please be as specific as you can.
For our high performance bridge deck mix mix (Class H), please see the reply above. For our normal bridge deck mix (Class K), we allow only one pozzolan substitution per mix with the following allowable replacements of cement: 19% fly ash by volume 45% slag cement by volume 8% silica fume by volume

Q4: **Have you used fibers in bridge deck mixes?**

No

Q5: **Have you used shrinkage reducing admixtures in bridge decks?**

Yes,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
We have used SRAs in four test mixes along with internal curing. During mix design development, we required four trial batches (one with no SRA, and three with different SRA dosage rates - low, medium, and high). The mix with the optimum performing SRA dosage rate was then used. Dosage rates differed for different SRAs.

Q6: Have you used lightweight aggregate in bridge deck mixes?	Yes, If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can. Lightweight fine aggregate has been used for internal curing.

Q7: What are your curing requirements for bridge decks?

7-day continuous wet cure with burlap and water.

Q8: Do you have smoothness requirements for bridge decks?	If yes, what criteria do you use and how is it measured. No surface deviations more than 1/8 inch in 10 feet when tested with a rolling straightedge.
Q9: Do you typically grind bridge decks?	For what reason? Smoothness, Noise, Other? If needed to meet smoothness requirements.
Q10: Do you seal bridge decks?	Additional Comments High performance bridge decks are not sealed, but normal concrete bridge decks are required to be sealed with silane.

Q11: What type of sealers do you allow/specify?

Silane	Specify
Siloxane	Do not use
Methylmethacrylate	Allow
Epoxy Chip Seal	Allow
Polymer Modified Overlay	Allow
Additional Comments?	We use silane on new (non-high performance) bridge decks and have used the other sealers to rehabiliate existing bridge decks.

Q12: What is the application rate for each sealer?

Additional Comments?	Per manufacturer's recommendations.

Q13: What is the typical performance life of a sealed joint?

Varies.

Q14: If you seal bridge decks, how often do you retreat?	If Yes, what is it? Does your Agency retreat or do you let a Contract for the work? That is up to District Maintenance, but existing decks are not frequently re-sealed. Maintenance funds are typically spent elsewhere.

Q15: Please attach a link to approved products list and approval process for joint sealants.

Please see Sections 624 and 708of our specifications (2010 Standard and 2016 Supplemental).
http://www.transportation.wv.gov/highways/contractadmin/specifications/Documents/2010%20Standard%20Specifications%20Roads%20and%20Bridges/Complete%20Publications/2010StandardRoadsnBridges.pdf

http://www.transportation.wv.gov/highways/contractadmin/specifications/Documents/2016%20Supplemental-FINAL.PDF

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.

If Yes, what is it?
Please see Section 623 of our 2010 standard specifications.
http://www.transportation.wv.gov/highways/contractadmin/specifications/Documents/2010%20Standard%20Specifications%20Roads%20and%20Bridges/Complete%20Publications/2010StandardRoadsnBridges.pdf

Q17: Any additional comments?

Respondent skipped this question

#21 COMPLETE

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PAGE 1

Q1: **State Representative**

Name	Chad Hayes
Agency	Wisconsin Department of Transportation
State / Province	WI
Email	chad.hayes@dot.wi.gov

Q2: **Do you a high performance bridge deck mix specification?**

If yes, what are the mix design requirements?
High Performance Concrete (HPC) Masonry Structures, Item SPV.0035. This special provision describes specialized material and construction requirements for high-performance concrete used in bridge structures. Conform to standard spec sections 501, 502, 710, and 715, as modified in this special provision. MODIFY STANDARD SPEC 501 AS FOLLOWS: 501.2.5.4.1 General Replace the entire text with the following: (1) Use clean, hard, durable crushed limestone with 100% fractured surfaces and free of an excess of thin or elongated pieces, frozen lumps, vegetation, deleterious substances or adherent coatings considered injurious. (2) Use virgin aggregates only. 501.2.5.4.2 Deleterious Substances Replace paragraph one with the following: (1) The amount of deleterious substances must not exceed the following percentages: DELETERIOUS SUBSTANCE PERCENT BY WEIGHT Shale 1.0 Coal 1.0 Clay lumps 0.3 Soft fragments 5.0 Any combination of above 5.0 Thin or elongated pieces based on a 3:1 ratio 15.0 Materials passing the No. 200 sieve 1.5 Chert[1] 1.0 [1] Material classified lithologically as chert and having a bulk specific gravity (saturated surface-dry basis) of less than 2.45. Determine the percentage of chert by dividing the weight of chert in the sample retained on a 3/8-inch sieve by the weight of the total sample. 501.2.5.4.3 Physical Properties Replace paragraph one with the following: (1) The department will ensure that Los Angeles wear testing conforms to AASHTO T 96, soundness testing conforms to AASHTO T 104 using 5 cycles in sodium sulfate solution on aggregate retained on the No. 4 sieve, and freeze-thaw soundness testing conforms to AASHTO T 103. The percent wear must not exceed 30 , the weighted soundness loss must not exceed 6 percent, and the weighted freeze-thaw average loss must not exceed 15 percent. 501.2.9 Concrete Curing Materials Replace paragraph three with the following: (3) Furnish burlap conforming to AASHTO M 182

(3) Furnish burlap conforming to AASHTO M 182, class 1, 2, 3, or 4. 501.3.2.4.3.3 Extended Delivery Time Delete paragraph one. 501.3.5.1 General Replace paragraph one with the following: (1) Use central-mixed concrete as defined in standard spec 501.3.5.1(2) for all work under this special provision. 501.3.5.2 Delivery Replace paragraph three with the following: (3) Deliver and completely discharge concrete within one hour beginning when adding water to the cement, or when adding cement to the aggregates. A decrease in air temperature below 60° F or the use of department-approved retarders does not increase the discharge time. 501.3.7.1 Slump Replace the entire text with the following: (1) Use a 2-inch to 4-inch slump. (2) Perform the slump tests for concrete according to AASHTO T 119. 501.3.8.2.1 General Replace the entire text with the following: (1) The contractor is responsible for the quality of the concrete placed in hot weather. Submit a written temperature control plan at or before the pre-pour meeting. In that plan, outline the actions the contractor will take to control concrete temperature if the concrete temperature at the point of placement exceeds 80° F. Do not place concrete without the engineer's written acceptance of that temperature control plan. Perform the work as outlined in the temperature control plan. (2) If the concrete temperature at the point of placement exceeds 80 F, do not place concrete for items covered in this special provision. (3) Notify the engineer whenever conditions exist that might cause the temperature at the point of placement to exceed 80 F. If project information is not available, the contractor should obtain information from similar mixes placed for other nearby work. (4) The department will pay the contract unit price under bid item "Ice for HPC Hot Weather Concrete Masonry" for the quantity of ice added to concrete required to reach a target concrete temperature of 80 F if the following conditions are met: 1. The un-iced concrete temperature exceeds 85 F. 2. The contractor has performed the actions outlined in the contractor's accepted temperature control plan. 3. The contractor elects to use ice. 501.3.8.2.2 Bridge Decks Replace the entire text with the following: (1) Do not place concrete for bridge decks when the ambient air temperature is above 80 F. (2) For concrete placed in bridge decks, submit a written evaporation control plan at each pre-pour meeting. In that plan, outline the actions the contractor will take to maintain concrete surface evaporation at or below 0.15 pounds per square foot per hour. Do not place concrete for bridge decks without the engineer's written acceptance of that evaporation control plan. Perform the work as outlined in the evaporation control plan. (3) If predicting a concrete surface moisture evaporation rate exceeding 0.15 pounds per square foot per hour, do not place concrete for bridge decks. (4) Provide evaporation rate predictions to the engineer 24 hours prior to each bridge deck pour. (5) Compute the evaporation rate from the predicted ambient conditions at the time and place of the pour using the nomograph, or computerized equivalent, specified in

CMM 5.25, figure 1. Use weather information from the nearest national weather service station. The engineer will use this information to determine if the pour will proceed as scheduled. (6) At least 8 hours before each pour, the engineer will inform the contractor in writing whether or not to proceed with the pour as scheduled. If the actual computed evaporation rate during the pour exceeds 0.15 pounds per square foot per hour, at the sole discretion of the engineer, the contractor may be allowed to implement immediate corrective action and complete the pour. MODIFY STANDARD SPEC 502 AS FOLLOWS: 502.3.5.4 Superstructures Delete paragraph five. 502.3.7.8 Floors Replace paragraph five with the following: (5) The contractor shall set the rails or tracks that the finish machine rides on, to the required elevation; and ensure they adjust to allow for settlement under load. Support the rails or tracks outside the limits of the finished riding surface. Do not support rails or tracks on the tops of girders or within the finished riding surface, without written permission of the engineer. Delete paragraphs thirteen, fourteen, and fifteen. Add the following as paragraphs nineteen, twenty, and twenty-one. (19) Do not place bridge deck concrete more than 10 feet ahead of the finishing machine. If there is a delay of more than 10 minutes during the placement of a bridge deck, cover all concrete (unfinished and finished) with wet burlap to protect the concrete from evaporation until placement operations resume. (20) Hand finishing, except for the edge of deck, must be kept to a minimum. The finishing machine must be equipped with a pan behind the screed. Apply micro texture using a broom or turf drag following the use of a 10-foot straight edge. Only finish by hand as necessary to close up finished concrete. Begin wet curing the deck immediately following the micro texture. (21) For bridge decks with a roadway design speed of 40 mph or greater, provide longitudinal grooving according to the provision included in this contract. 502.3.8.1 General Replace paragraph one with the following: (1) Maintain adequate moisture throughout the concrete mass to support hydration for at least 14 days. 502.3.8.2.1 General Replace the entire text with the following: (1) Wet-cure the concrete for bridge decks, structural approach slabs, sidewalks and raised medians for 14 days by use of a soaker hose system, or other engineer-approved methods. Cover the finished surface of bridge decks and overlays with one layer of wetted burlap or wetted cotton mats within 10 minutes after the finishing machine has passed. Apply the burlap/cotton gently so as to minimize marking of the fresh concrete. Keep the first layer of burlap/cotton continuously wet until the bridge deck or overlay is sufficiently hard to apply a second layer of wetted burlap/cotton. Immediately after applying the second layer of burlap/cotton, continue to keep the deck wet until placing and activating the soaker hose system. Throughout the remainder of the curing period, keep the burlap/cotton continuously wet with soaker hoses hooked up to a continuous water source. Inspect the

burlap/cotton twice daily to ensure the entire surface is moist. If necessary, alter the soaker hose system as needed to ensure the entire surface is completely covered and stays moist. After 48 hours from the time of completion of the bridge deck or overlay pour, the soaker hose system and burlap/cotton may be covered with polyethylene sheeting. Provide a continuous flow of water through the soaker hose system for the entire curing period. (2) Do not uncover any portion of the deck at any time for any reason during the first 7 days of the curing period. (3) Set up and test the fogging system before each bridge deck, raised median and sidewalk pour. The fogging system must remain set up and in operating condition for the duration of the pour. 502.3.8.2.3 Decks Delete the entire text. 502.3.8.2.4 Parapets Replace the entire text with the following: (1) Cure the inside and outside concrete faces and tops of railings or parapets by covering with wetted burlap immediately after form removal and surface finish application. Keep the burlap thoroughly wet for at least 7 days; or by covering for the same period with thoroughly wet polyethylene-coated burlap conforming to 501.2.9. (2) Secure coverings along all edges to prevent moisture loss. 502.3.9.6 Bridge Decks Replace note two within paragraph one with the following: 2. Protect the underside of the deck, including the girders, for bridge deck and overlay pours by housing and heating when the national weather service forecast predicts temperatures to fall below 32 F during the cold weather protection period. Maintain a minimum temperature of 40 F in the enclosed area under the deck for the entire 14-day curing period. 502.5.1 General Replace paragraph one with the following: (1) The department will pay for measured quantities at the contract unit price and incidentals necessary to complete the work under the following bid item: ITEM NUMBER DESCRIPTION UNIT SPV.0035 HPC Masonry Structures CY MODIFY STANDARD SPEC 710 AS FOLLOWS: Add the following subsection: 710.5.7 Chloride Penetration Resistance (1) For each new or changed mix design, measure chloride penetration resistance according to AASHTO T 277 (Rapid Chloride Permeability Test) at a frequency of 1 test per 3 months (quarterly) of production. (2) Permeability samples for AASHTO T 277 testing must be stripped of their molds and wet cured to an age of 7 days in a standard moist room or water tank. After 7 days, submerge the samples in water heated to 100° F until an age of 28 days. Upon completion of the curing process, obtain one sample from each cylinder and test according to AASHTO T 277. (3) Ensure that the initial accepted mix designs meet the chloride penetration resistance limit of 1500 coulombs based on the AASHTO T 277 Rapid Chloride Permeability test. Chloride resistance testing conducted quarterly using AASHTO T 277 Rapid Chloride Permeability Test during production will not be used for acceptance of previously accepted mixes and concrete masonry mixed and placed according to the contract requirements. For quarterly chloride resistance test results exceeding 1500 coulombs, the department

results exceeding 1500 coulombs, the department may require adjustment of the concrete mix going forward to improve the chloride penetration resistance. MODIFY STANDARD SPEC 715 AS FOLLOWS: 715.2.3.2 Structures Replace paragraph two with the following: (2) Provide a minimum cementitious content of 470 pounds per cubic yard and a maximum cementitious content of 540 pounds per cubic yard. For all superstructure and substructure concrete, unless the engineer approves otherwise in writing, conform to one of the following: 1. Use class C fly ash or grade 100 or 120 slag as a partial replacement for Portland cement. For binary mixes use 15% to 30% fly ash or 20% to 30% slag. For ternary mixes use 15% to 30% fly ash plus slag in combination. Percentages are stated as percent by weight of the total cementitious material in the mix. 2. Use a type IP or IS blended cement. Add the following subsection: 715.2.3.3 Trial Mixes (1) Develop and test each mix to be used for HPC Masonry Structures. Produce a laboratory trial mix for each mix, as well as a trial mix from each plant used to supply the project. Test all mixes at a department-qualified laboratory. (2) The laboratory trial mix data must include the results of the following tests: 1. AASHTO T 119 Slump of Hydraulic Cement Concrete. 2. AASHTO T 121 Mass per Cubic Foot, Yield 3. AASHTO T 152 Air Content. 4. AASHTO T 22 Compressive Strength. 5. AASHTO T 277 Rapid Determination of the Chloride Permeability of Concrete, using the modified curing procedure according to 710.5.7(3) herein. 6. AASHTO T 309 Temperature. 7. Water Cement Ratio. (3) The 28-day compressive strength must be greater than or equal to 4000 psi. The 28-day results of the permeability test must be less than or equ

Q3: Do you allow supplementary cementitious materials in bridge deck mixes?

Yes,

If yes, what types? What percentage? Please be as specific as you can. http://wisconsindot.gov/rdwy/stndspec/ss-07-15.pdf#ss715 Provide a mix grade containing fly ash (A-FA), slag (A-S), both fly ash and slag (A-T), or blended cement (A-IP, A-IS, or A-IT) Ensure that the cementitious content equals or exceeds 565 pounds per cubic yard. Unless the engineer approves otherwise in writing, conform to one of the following: 1. Use class C fly ash or grade 100 or 120 slag as a partial replacement for cement. For binary mixes use 15% to 30% fly ash or 20% to 30% slag. For ternary mixes use 15% to 30% fly ash plus slag in combination. Replacement values are in percent by weight of the total cementitious material in the mix. 2. Use a type IP, IS, or IT blended cement.

Q4: Have you used fibers in bridge deck mixes?

Yes,

If yes, what type of fibers have you used? What dosage rate? Please be as specific as you can.
Wis.DOT does not currently use fibers in bridge decks. We have tried fibers at different times for research projects only and that includes 80 lbs/cy of steel fibers or 3 lbs/cy of polypropylene non structural fibers.

Q5: Have you used shrinkage reducing admixtures in bridge decks?

Yes,

If yes, what dosage rate? Comments on performance. Please be as specific as you can.
Wis.DOT has only used SRA on a research basis only. We do not currently allow SRA's because they are not compatible with air-entrained concrete (they act as an air detrainer).

Q6: Have you used lightweight aggregate in bridge deck mixes?

Yes,

If yes, for what purpose? Internal curing, reduced dead load on bridge? What dosage rate? Please be as specific as you can.
Only in some bascule and pedestrian structures. Reduced dead loads.

Q7: What are your curing requirements for bridge decks?

http://wisconsindot.gov/rdwy/stndspec/ss-05-02.pdf#ss502

502.3.8.2.3 Decks
(1) For structures under 100 feet in length, cure the concrete in decks, medians, and sidewalks for at least 7 days with polyethylene-coated burlap or other coated material conforming to 501.2.9. As soon as the concrete sets sufficiently to support the covering, place the coated burlap with the coated side up; or perform an initial cure of the concrete by using wetted burlap for at least 12 hours and then apply the coated burlap to a thoroughly wetted concrete surface. Place each strip or sheet of coated burlap so that
it overlaps the preceding sheet by at least 12 inches. Secure the coated burlap covering in place. Ensure adequate moisture is present on the surface of the floor, wearing surfaces, or sidewalks beneath the curing material for the 7-day curing period. (2) For Structures 100 feet or greater in length, cure the concrete in decks, medians, and sidewalks by the following method. Begin curing the horizontal concrete surfaces by fogging within 15 minutes of finishing and tining. Apply the fog or fine water spray so that no water marks result and no mortar washes from the concrete surface. Keep the concrete surface continuously wet by fogging until applying the burlap strips to the finished concrete. Wet the burlap immediately after placement. During the first day, until placing the soaker hose system, keep the burlap continuously wet. Through the remainder of the curing period, keep the burlap continuously wet with soaker hoses hooked up to a continuous water source. Inspect the
burlap on a daily basis to ensure that the entire surface is moist. If necessary, alter the soaker hose system as needed to ensure the entire surface is moist. Do not use white polyethylene sheeting or plastic coated burlap blankets. Continue moist curing at least 7 days.

For HPC bridge decks everything above is the same except it needs to be cured for 14 days.

Q8: Do you have smoothness requirements for bridge decks?

If yes, what criteria do you use and how is it measured.
Only on a pilot basis currently. Measured with a light weight profiler, IRI.

Q9: Do you typically grind bridge decks?

No

Q10: Do you seal bridge decks?	Additional Comments http://wisconsindot.gov/rdwy/stndspec/ss-05-02.pdf#ss502 502.2.11 Crack and Surface Sealers Revise 502.2.11 to clarify materials for crack, deck, and parapet sealing. (1) Furnish crack and surface sealers from the department's approved products list as follows: - Crack sealer: Low Viscosity Crack Sealers for Bridge Decks list. - Protective surface treatment: Concrete Protective Surface Treatment list. - Pigmented surface sealer: Cure and Seal Compound for Non-trafficked Surfaces for Structural Masonry list. Approved products list for sealers: http://wisconsindot.gov/Documents/doing-bus/eng-consultants/cnslt-rsrces/tools/appr-prod/ap-current/concrete-prot-surf-trtmt-6-10-2014.pdf

Q11: What type of sealers do you allow/specify?

Silane	Specify
Siloxane	Do not use
Methylmethacrylate	Do not use
Epoxy Chip Seal	Specify
Polymer Modified Overlay	Do not use

Q12: What is the application rate for each sealer?

Silane	Specify
Siloxane	Do not use
Methylmethacrylate	Do not use
Epoxy Chip Seal	Specify
Polymer Modified Overlay	Do not use
Additional Comments?	Per manufacture recommendation.

Q13: What is the typical performance life of a sealed joint?	*Respondent skipped this question*
Q14: If you seal bridge decks, how often do you retreat?	If Yes, what is it? Does your Agency retreat or do you let a Contract for the work? 3 year cycle when possible. LET a contract for the work.

Q15: Please attach a link to approved products list and approval process for joint sealants.

No approved products list.

http://wisconsindot.gov/rdwy/stndspec/ss-05-02.pdf#ss502

See 502.2.7

Q16: Do you have a shotcrete specification? If so can you provide a copy of or link to your specification.	No