Make this Section a part of the Standard Specifications:

"SECTION 676 - CONCRETE DECK REPAIR

676.01 Description. This section includes qualifying for the work by providing documentation and meeting qualification specifications; conducting construction and public traffic control; locating and confirming the size of defective areas in the concrete roadway decking and proposing areas to repair and then obtaining the Engineer's acceptance of areas to repair; carrying out the repairs including such steps as; preparing the repair areas by removing material and roughening the surface, lowering reinforcing steel with inadequate concrete cover, replacing damaged reinforcing steel, abrasive blasting and cleaning the surfaces, replacing the removed concrete, finishing and curing the concrete, replacing joints and traffic loop detectors damaged by the repairs; replacing pavement markings; performing tests; and providing documentation of work and tests completed.

676.02 Materials. All materials used shall be compatible with the materials specified in Section 677 - Bridge Polyester Concrete Overlay.

Fine Aggregate for Concrete	703.01
Coarse Aggregate for Concrete	703.02
Admixtures	711.03
Water	712.01
Reinforcing Steel	602

(A) Replacement Concrete. Use replacement concrete that is a very early strength latex modified concrete (VESLMC) with fibers which provides a low color contrast with the surrounding deck surfaces. The nominal maximum size of coarse aggregate shall be 3/8 inch. The Engineer may accept an alternative replacement concrete that is equal or better in performance, when compared to the characteristics stated below.

(1) The VESLMC shall use cement which is finished calcium sulfoaluminate that contains no more than 2 percent C_3A and not greater than 0.03 percent shrinkage in accordance with ASTM C157. The amount of cement in the VESLMC shall not exceed 760 pounds per cubic yard.

(2) The VESLMC shall include a modified styrene butadiene copolymer latex that meets the requirements of FHWA Research Report RD-78-35.

(3) The VESLMC shall also include 1-1/2 inch length alkali-resistant (AR) glass fiber at 6 pounds per cubic yard.

(4) Corrosion inhibitor shall be water based amine carboxylate corrosion inhibitor. Use 1 ½ pints of corrosion inhibitor per cubic yard.

(5) The VESLMC concrete shall also meet the following requirements:

Characteristics	Requirement	Test Method
Minimum Compressive Strength At 3 hours At 28 days	 3000 psi 6000 psi	ASTM C39
Air Content	4 percent maximum	ASTM C231
Abrasion Resistance	Depth of wear not to exceed 0.035 inches in 60 minutes	ASTM C779
Modulus of Elasticity Minimum at 3 hrs Maximum at 56 days	 3,000,000 psi 4,000,000 psi	ASTM C469
Ring Test	No cracking at age less than 28 days	ASTM C1581
Flexural Fatigue Strength (based on a testing arrangement similar to ASTM C78)	550 psi at 3 million cycles	ASTM C78* As modified below.
Rapid Chloride Permeability Test	Charge passed less than 100 coulombs at 63 days	ASTM C1202
Flexural Strength (Modulus of Rupture at 28 days)	1100 psi	ASTM C78

Modified ASTM C78 Testing Procedure. To modify the testing procedure for determination of fatigue resistance, the following parameters were used.

a) Load application frequency of 5 Hz without rest periods

b) Sinusoidal pulse was used to vary the loading amplitude.

c) Load was initially applied 10-20% stress ratio to seat the sample and insure gauge functionality.

d) Servo-hydraulic universal test machine with feedback controlled close-loop configuration, maximum load capacity 20 kips.

e) Maximum/minimum ration 10%

f) Specimens covered with wet burlap and kept moist during testing.

g) Test preformed at 50% of static flexural strength.

h) Three concrete beam samples tested.

1) Provide a certification with certified test data from the concrete manufacturer and cement manufacturer that the replacement concrete complies with these requirements. Perform the material testing in the presence of the Engineer or as acceptable to the Engineer.

2) In addition to the aforementioned requirements, provide a strength-maturity relationship for the 2, 3, 4, 6, and 12 hour test ages from trial batches of the proposed replacement concrete. Allow the Engineer to monitor additional specimen(s) using the maturity meters provided in subsection 676.03 Construction Requirements.

(B) Concrete Sealer. The concrete sealer to be used after completing the deck repairs shall meet the following criteria:

(1) 100% Silane sealer containing corrosion inhibitor.

(2) No greater than 0.5 visual rating after 50 cycles according to ASTM C672, Standard Test Method for Scaling Resistance of Concrete Surfaces exposed to Deicing Chemicals with application of one coat at 125 square feet per gallon.

(3) No more than 0.75% increase in weight during ASTM C156, Standard Test Method for Water Retention by Liquid Membrane-Forming Curing Compounds for Concrete with application of one coat at 125 square feet per gallon.

(4) At least 78% reduction with application of one coat at 125 square feet per gallon according to ASTM C1218, Standard Test Method for Water Soluble Chloride in Mortar and Concrete.

676.03 Construction Requirements. Conform to the requirements of Section 503 and as required in these specifications.

The Contractor shall retain a Hawaii Licensed Structural Engineer to review the repair procedures and continually review the daily areas to be repaired by the Contractor and to provide assurance to the Engineer that the areas under repair do not endanger the public, State forces and Contractor forces; or structurally impair the structure, based on the anticipated loads.

(A) Submittal Requirements. At least four weeks prior to the start of this work, provide eight copies of the following submittals in one complete set for acceptance. Indicate clearly the name of the product and its manufacturer on pertinent submittals. No work that is related to these submittals shall be performed until written acceptance has been received.

(1) Certifications, test data and assurances required in Subsection 676.02 - Materials.

(2) Information on the replacement concrete including shelf life, working times, and placement rates,

(3) Detailed information on all equipment and materials that will be used for all aspects of the repair work including equipment for sounding the deck, determining surface profiles and compressive strengths, demolishing concrete, cleaning the repair areas, quality control/quality assurance (QC/QA) plan, placing (handling, mixing, consolidating, finishing, curing and texturing) of concrete, and post repair testing for delaminations. If equipment includes use of a continuous volumetric concrete mixer, provide the documentation required under Subsection 676.03(C) - Continuous Volumetric Concrete Mixers.

(4) Detailed step by step procedures for all aspects of the repair work including sounding the deck, determining surface profiles and compressive strengths, demolishing concrete, removing concrete, cleaning the repair areas, preparing any repair substrata, placement (handling, mixing, consolidating, finishing, curing and texturing) of concrete, and post repair testing for delaminations.

(5) Detailed plans and procedures to be in compliance with the requirements of Section 107 - Legal Relations and Responsibility to the Public including complying to noise variances, and controlling of work to appropriately minimize dust and air borne debris from concrete demolition, abrasive blasting, mixing and placing concrete, and cleaning operations, and to prevent water runoffs.

(6) Planned actions to maintain adherence to limitations and requirements of the following variables with regards to concrete repair work:

a) Ambient air temperature,

b) Wind speed,

c) Temperature of plastic concrete delivered.

d) Relative humidity

e) Evaporation rate of concrete bleed water or moisture.

f) Theoretical evaporation rate as determined from ACI 305 Hot Weather Concreting

g) Rain

h) Placement of repair concrete

i) Preparation of any concrete substrata

j) Equipment and traffic control near or on repair areas during placement and curing operations

(7) Planned emergency procedures for concrete repair areas that cannot be appropriately constructed within the allotted closure hours or if preparation of work area results in a complete depth penetration of the deck.

(8) Procedures for documentation of all aspects of repair work including the measurement and locations of repair areas.

(9) Test reports of compressive strengths and maturity readings of repaired areas during the progress of the work.

(B) Early Strength Monitoring. Provide a minimum of two wireless sacrificial sensor type maturity meters to determine concrete conformance to early strength requirements. The maturity meters shall have a secure and unalterable means of collecting data.

Verify the calibration of the maturity meters in the presence of the Engineer prior to use on the project by placing a temperature sensor in a controlled temperature water bath and recording whether the indicated temperature agrees with the known temperature of the water bath. Perform temperature comparison test at approximately 5 different temperatures, 75°F, 100°F, 125°F, 150°F and 175°F. The temperature recording device shall be accurate to within ± 2°F.

Develop strength-maturity relationship using only maturity meters, materials and conditions to be used or encountered on the project for all replacement concrete prior to placing any concrete on the project. Notify the Engineer when the development of the maturity curve will be done and conduct all tests in the presence of the Engineer in accordance with ASTM C1074 Estimating Concrete Strength by the Maturity Method at the concrete producer's laboratory or other approved laboratory facilities. For every concrete design, prepare a minimum size of each batch of concrete of at least one cubic yard and cast a minimum of 15 cylinders in accordance with AASHTO T23. Test three cylinders at ages of 2, 3, 4, 6, and 12 hours. Submit all results and curves to the Engineer for review and acceptance.

Any alterations in mix proportions or material source or type of material, in excess of those tolerable by batching variability, requires the development of a new strength-maturity relationship prior to use. This includes a change in material type, source, or proportion of cement, fly ash, coarse aggregate, fine aggregate, fibers or admixtures. The Engineer will require the development of a new strength-maturity relationship for any changes in the water to cement ratio of greater than 0.02.

Submit the following information of the strength-maturity relationship prior to placing any concrete on the project:

(1) Project number, concrete mix number and test date.

(2) Air content, slump and total free water of the batch of concrete.

(3) Type and amount of admixtures used in the batch of concrete.

(4) Strength of each specimen and average strength of specimens at each test age.

(5) Maturity index for each instrumented test specimen and the average maturity index for the instrumented specimens at each test age.

(6) Graphs of the average compressive strength verses the average value of the maturity index as described in the strength-maturity relationship of ASTM C1074.

Provide a minimum of two maturity meters at the project site for monitoring the early strength of concrete during each section of concrete placement. Assure that the batteries for the maturity meters are adequately charged prior to use. Use the same brand and type of maturity meters and thermocouple sensors as those used to develop and verify the strength-maturity relationship.

Install at least two maturity meter sensors per concrete placement with locations to be determined by the Engineer. Place sensors no closer than 4 inches from any formed surface or edge of slab being placed and at mid-depth of the repair section. Anchor sensors so that they remain in the middle of the repair section. Do not tie any sensor to reinforcing steel, any material that may corrode or any formwork. Modify means and methods subsequent to failures of sensors to prevent any reoccurrence.

Conduct a validation test for every 14th day or fraction thereof of concrete placement relationship by comparing an average compressive strength of three cylinders to the compressive strength as determined in the accepted strength-maturity relationship to verify that the in-place concrete compressive strengths are accurately represented. Submit the validation data with the same extent of information as the initial strength-maturity relationship submittal. The Engineer will consider the strength-maturity relationship valid for the predicted strengths within 5 percent of the actual compressive strength. Make a mathematical adjustment to the strength-maturity relationship when the actual average compressive strength for three validation tests are 5 to 10 percent above or below the predicted compressive strength as directed by the Engineer. Develop a new strength-maturity relationship when the actual average compressive strength for three validation tests exceeds 10 percent above or below the predicted compressive strengths.

The Contractor shall take surface temperature readings with a non-contact infrared thermometer after the concrete is poured. The readings shall be correlated to the actual times between the start and finish of placement operations. Areas with high or low temperature reading irregularities shall be further investigated using a rebound hammer in accordance with ASTM C805. These rebound hammer readings shall be compared to other readings taken where surface temperatures are satisfactory. A minimum 3000 psi compressive must be confirmed prior to the opening of the roadway. Repaired areas with temperature irregularities and which fail the rebound hammer testing prior to the roadway opening shall be removed and replaced at the Engineer's request. Areas which are identified with irregularities but which meet the 3000 psi minimum strength prior to roadway opening can be tested again after 24 hours to ensure that this area of concrete is maturing uniformly with the surrounding concrete placed at the same time. The Engineer will determine the need for replacement.

(C) Continuous Volumetric Concrete Mixers. The Engineer will allow the use of continuous volumetric concrete mixers. Use standard manufactured continuous volumetric concrete mixers that are capable of combining aggregate, cement, water, admixtures into a uniform mixture within the specified mixing time and comply with ASTM C 685. The volumetric continuous concrete mixers shall also conform to the following requirements:

(1) Proportion cement, aggregate, water and admixture by volume.

(2) Carry each ingredient in separate compartments and produce a minimum of 6 cubic yards of concrete.

(3) Measure the cement as it is introduced into the mixture with a recording meter.

(4) Control the flow of water and admixtures as they are introduced into the mixture with calibrated and adjustable flow control valves,

(5) Indicate the number of gallons used to the nearest 0.10 gallons with a water flow control meter.

(6) Proportion and blend all components of the concrete mixture on a continuous or intermittent basis via automatic calibration.

Calibrate and perform uniformity checks in accordance with ASTM C685 and manufacturer's recommendations to ensure proper proportioning and consistency of concrete. Provide the Engineer with the means to verify the calibration of the mixer and uniformity of the mix. Submit mixer calibration and uniformity reports and equipment specifications for review and approval. Do not use the continuous volumetric concrete mixer until the submittals are approved by the Engineer.

(D) Just-In-Time Training.

Just-in-Time Training (JITT) shall be mandatory, and consist of a formal joint training class on Very Early Strength Latex Modified Concrete (VESLMC) and paving techniques. Construction operations for rapid strength concrete shall not begin until the Contractor's and the Engineer's personnel have completed the mandatory JITT. The Contractor's personnel included in the list of participants for the Pre-Operation Conference along with the Engineer's representatives shall attend JITT;

The JITT session will be conducted for not less than 4 hours. The training class may be an extension of the Pre-Operation Conference and shall be conducted at the project field location convenient for both the Contractor's and the Engineer's project staff. Scheduling and completion of the JITT session shall be completed at least 15 days prior to the start of construction of VESLMC replacement concrete. The class shall be held during normal working hours.

The JITT instructor shall be experienced in the construction methods, materials, and test methods associated with VESLMC replacement concrete and paving techniques. The instructor shall not be an employee of the Contractor or a member of the Engineer's field staff. A copy of the syllabus, handouts, and presentation material shall be submitted to the Engineer at least 7 days before the day of the training and shall be furnished to each participant. Selection of the course instructor, the course content and training site shall be as mutually agreed to by the Contractor and the Engineer. The instructor shall issue a certificate of completion to the participants upon the completion of the class. The certificate shall include the course title, date and location of the class, the name of the participant, instructor's name, location and phone number.

The Contractor's or Engineer's personnel involved with VESLMC replacement concrete operations will not be required to attend JITT if they have completed similar training within the previous 12 months of the date of the JITT for this project. The Contractor shall provide a certificate of class completion as described above for each staff member to be excluded from the JITT session. The final determination for exclusion of any staff member's participation will be as determined by the Engineer. All attendees of the JITT shall complete, and submit to the Engineer, an evaluation of the training. The course evaluation form will be provided by the Contractor.

It is expressly understood that Just-In-Time Training shall not relieve the Contractor of any responsibility under the contract for the successful completion of the work in conformity with the requirements of the plans and specifications.

(E) Pre-Operational Conference. The Contractor and concrete manufacturer and cement manufacturer's representative involved in construction operation of the repairs shall meet with the Engineer, at a mutually agreed time, to discuss and verify the methods of accomplishing all phases of the repair operations, contingency planning, and standards of workmanship for the completed items of work. The Contractor's superintendents, foremen, subcontractors, concrete and cement manufacturers' technical representatives, and all key personnel involved with the repair shall attend the pre-operation conference. Placement of replacement concrete shall not begin before the Engineer accepts the pre-operational conference as completed.

(F) Pre-Operational Demonstration. The Contractor shall demonstrate the repair work on a trial test slab using the same step by step procedures, equipment and materials as proposed for the actual repair operation in the presence of the repair material manufacturers' representatives, and the Engineer. The demonstration shall be on a suspended slab 5 feet above the ground on a repair area approximately 6' wide x 10' long with support along the longitudinal edges. The State may allow a trial test slab on a planned repair area under the following conditions:

(1) Traffic control is in accordance with contract requirements and is incidental. Liquidated damages apply.

(2) Test slab location to be agreed to by the State in a location with minimal impact to traffic and on a non-travel lane in the event the pavement repair is incomplete or unsound. Direct access to the underside of the test slab shall be provided for State inspection.

(3) An emergency repair procedure accepted by the State shall be in place to restore and reopen the work area to traffic.

(4) Unacceptable repair shall be redone at no additional cost to the State.

The demonstration shall include the following:

(1) The Contractor's superintendents, foremen, subcontractors, manufacturer's technical representatives, and all key personnel involved with the repair shall be present.

(2) Unless allowed within the project area above, the trial test slab location shall be outside the project limits, acceptable to the Engineer and require no traffic control.

(3) The concrete test slab shall be steel reinforced, 6 ½ inches thick, and have a minimum concrete compressive strength of 3000 psi at the time of the test. The reinforced concrete slab shall include no. 5 reinforcing bars that are 6 inches on centers transversely and 12 inches on centers longitudinally for both top and bottom mats. The top mat transverse bars shall have concrete cover of 1 ½ inches. The cover of the bottom mat shall be 1 ¼ inches. The Contractor, prior to performing the repair demonstration, shall have the details of the trial test slab accepted by the Engineer.

(4) The area of the slab to be repaired shall be determined by the Engineer.

(5) Demonstrate splicing of reinforcing bars by lap welding.

(6) Qualification tests in accordance with Subsection 676.03(S)(1) - Qualification Testing shall be demonstrated on the 6' x 10' test area.

(7) The repair materials shall be mixed and used as recommended by the manufacturer.

(8) Strength Testing and Verification: Using a certified laboratory, perform qualification testing consisting of three sets of concrete compressive strength tests of cylinders at three hours and at 28 days. Include monitoring of samples using maturity meters and logging sensors to verify strength using the strength-maturity relationship data.

Placement of replacement concrete within the project limits shall not begin before the Engineer accepts the pre-operational demonstration as completed and acceptable.

(G) Authorization to Work. Proceed with the repair work within the project limits when the first six of the following items and either the seventh or eighth item has met the requirements and is accepted by the Engineer in writing.

(1) Subsection 676.03(A) - Submittal Requirements.

(2) Subsection 676.03(B) - Early Strength Monitoring.

(3) Subsection 676.03(C) - Continuous Volumetric Concrete Mixers.

(4) Subsection 676.03(D) - Just-In-Time-Training.

(5) Subsection 676.03(E) - Pre Operational Conference.

(6) Subsection 675.03(F) - Pre-Operational Demonstration and Qualification.

(7) Temporary Work Acceptance. The Engineer accepts a request in writing to do a specific work on a particular day.

(8) Qualified to Work. The Engineer accepts the most recent required qualification tests and all the following criteria are satisfied. Otherwise, request and use a temporary work acceptance from the Engineer to be authorized to work as an unqualified Contractor.

(a) No conditions exist that would require new qualification testing.

(b) No quality assurance tests have failed to meet specification requirements since the previous accepted tests.

(c) No concrete repairs have failed. This criterion is not applicable if the Engineer accepts the plans for remedial actions for the failed repairs and those failed repairs do not hold up further concrete repair work.

(H) Deck Condition Survey. The roadway plans are a guide to illustrate the general locations of areas to be visually examined and sounded, and not as a specification of specific repair areas. Damaged areas shall be determined by the Contractor in accordance with visual observation and ASTM D4580. Mark the locations and limits of deteriorations and delaminations as determined by the visual and sounding methods, then mark additional areas according to the plans with perimeters of the proposed repair areas being perpendicular and parallel to the traffic lanes. The Contractor shall provide drawings of the damaged locations including the outlines of the proposed repair areas. The total area of repairs shall be calculated and provided to the Engineer with the drawings. The Contractor shall not begin any repair until the Engineer verifies and accepts the location and size of the area to be repaired. The Engineer may direct the Contractor to do repairs outside of the areas determined in the deck condition survey. As part of the deck condition survey, In areas near joints, the Contractor will determine if the structural steel armor for the joints is in need of repair. Upon agreement by the Engineer, the Contractor will propose a method of repair as approved by a Hawaii licensed structural engineer for the Engineers approval.

(I) Preparation of Repair Areas. Use the procedures of ICRI (International Concrete Repair Institute) Guideline No. 03730 "Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Reinforcement Steel Corrosion", ICRI Guideline 03732 "Selecting and Specifying Concrete Surface, Surface Preparation for Sealers, Coatings and Polymer Overlays" sections of ACI 546.1R-80 (Reapproved 1997) "Guide for Repair of Concrete Bridge Superstructures". The Contractor shall be responsible for any falsework requirements, debris, noise and pollution control; on and below the viaduct repair area. Provide falsework calculations performed and stamped by a Hawaii licensed structural engineer. Prepare the repair areas as follows:

(1) Removing Material:

(a) Survey the concrete cover to avoid cutting the reinforcing steel.

(b) Saw cut the limits of the repair area ½ inch deep, or to the top of transverse top reinforcing steel if the depth of cover is less than ½ inch.

(c) Remove the concrete within the limits of repair. Use chipping or pneumatic tools weighing less than 15 pounds. Hydrodemolition with controlled pressure settings may be used to remove concrete. Special care shall be taken to ensure compliance with Section 676.03(A) and especially 676.03(A)(5).

(d) Concrete removal shall not damage the portion of the structure that is to remain. If the structure is damaged beyond the repair area limits required by the contract, Contractor shall repair the damaged portion according to the contract at no increase in contract time or contract price.

(e) Remove sound concrete beyond unsound areas to provide a good bond in accordance with the contract.

(f) Deck repairs shall be done to a depth where sound concrete is encountered. If reinforcing steel is encountered the depth shall be increased to allow proper bond between the VESLMC and reinforcing steel.

(g) No material is allowed to fall or flow into streams or drainage systems.

(h) The reinforcing steel at the edges *of* the repair areas shall be well bonded to the surrounding deck with no significant loose scaly rust or contaminants that would interfere with concrete bond.

I) Debris and waste material shall be disposed of at a disposal site in accordance with all applicable Federal State and County laws, rules and ordinances and as accepted by the Engineer.

2) Corroded Reinforcing Steel. Strengthen any reinforcing steel that is found to have lost 25% or more of the original cross sectional area by weld lap splicing new reinforcing steel according to Section 602 - Reinforcing Steel and as shown in the plans.

3) Preparation of the Repair Area. Sandblast the concrete substrate and any reinforcing steel in the repair area. Remove any contaminants, heavy rust or scale, dust, loose concrete and sand that may affect bonding of the repair concrete. Any thin rust or bits of hard mortar that are tightly adhered to the reinforcing steel need not be removed.

The reinforcing steel shall generally be shiny (some rust and hard mortar allowed) and welds with their heat affected area shall be shiny (bare metal only) after sand blasting. Hydroblast the exposed area with fresh water. Spare abrasive blasting equipment shall be provided and kept on the project site during working hours. Remove debris, wash water and waste material using vacuum machines and properly dispose outside the project limits at a disposal site accepted by the Engineer. Brooms shall not be used on the prepared surface for cleaning. The repair area shall be free of dust, dirt, oil, grease and other contaminants that may affect bonding of the concrete repair mortar. The Contractor shall protect the public from dust pollution and other damages resulting from the blast cleaning operation. The Contractor shall prevent abrasives and debris from entering drainage systems and streams.

4) Girder Stirrups. Stirrup hooks shall have 1 ½ inch concrete cover prior to placing replacement concrete. All reinforcement shall be cold bent or replaced as necessary to provide the 1 ½ inch concrete cover. This work shall be considered incidental to the Repair for Concrete Deck pay item.

(J) Traffic and Equipment Control on Bridge.

(1) Construction vehicles shall not exceed a 5-mph speed limit within 100 feet longitudinally and 12 feet transversely of the placement-area for both arrival and departure directions.

(2) Equipment and vehicles shall not contaminate or drive on the prepared deck surface.

(3) The Contractor shall not permit compressors or other equipment that produce vibrations on the precast girder span undergoing deck repair. Equipment shall not be located on precast girder spans undergoing deck repair unless approved by the Engineer.

(4) Vehicular traffic shall not exceed a 15-mph speed limit on the bridge span being repaired during concrete pour and cure.

(5) The replacement concrete shall have minimum compressive strength of 3000 psi as determined by Early Strength Monitoring prior to opening to traffic.

(6) Contractor shall not allow any equipment or vehicles within 4 feet laterally from any repair for the duration of traffic control. This is a structural integrity issue.

(7) The bridge deck shall not be used as a storage area for equipment or for stockpiling materials. Loads exceeding the legal limit shall not be used on the bridge unless an overload and/or oversize permit has been approved by the Engineer.

(K) Placement of Replacement Concrete.

(1) The concrete manufacturer's and cement manufacturer's technical representatives shall be present during initial repair work and as requested by the Engineer at no increase in contract time or contract price.

(2) A technical representative shall be capable and knowledgeable about the product he represents, e.g., know under what conditions the product should be placed for optimal results, know what causes defects or problems, and know how to troubleshoot the product.

(3) A technical representative shall provide aid and field supervision to assure that the work is properly installed and performed as recommended by the manufacturer and accepted by the Engineer at no increase in contract time or contract price.

(4) The Contractor shall adhere to recommendations made by the technical representative and accepted by the Engineer at no increase in contract time or contract price.

(5) Place the replacement concrete according to the replacement concrete manufacturer's and cement manufacturer's recommendations and instructions and as accepted by the Engineer. The Contractor shall inform the Engineer in writing of any work that is not in conformance with the manufacturer's recommendation.

(6) A bonding agent recommended by the replacement concrete manufacturer and cement manufacturer shall be used where replacement concrete is placed against existing concrete. Use bonding agent in accordance with the manufacturer's recommendations.

(7) Unless otherwise directed by the manufacturer, maintain the surfaces to be repaired wet for a minimum of 1 hour prior to placement and remove all excess surface moisture using oil free compressed air just prior to placing the replacement concrete.

(8) Any falsework and formwork required shall be considered incidental to this work.

(9) Replacement concrete shall be mixed as recommended in writing by the manufacturer,

(10) Runoff from the adjacent deck is not allowed on the repair area.

(L) Consolidation. Consolidate the replacement concrete as recommended by the manufacturer.

(M) Finishing. Finish while the replacement concrete is plastic and workable. Position float parallel to road centerline and finish in the transverse direction passing gradually from one side of the pavement to the other. Move ahead along pavement centerline advancing not more than one-half of float length. Finish the replacement concrete to meet the requirements of the Surface Testing subsection. Texture surface of the replacement concrete to match existing adjacent textures.

(N) Protection and Curing. Protect freshly placed replacement concrete from plastic shrinkage, premature drying, excessive hot temperatures and direct wind. See Section 676.03(A) for submittal requirements.

(O) Joints.

(1) Construction Joints. Use construction joints only with the acceptance of the Engineer and in accordance with the Contract.

(2) Steel Armor Angles and Expansion Joints. Armor angles and expansion joints shall not be altered or damaged and shall be restored to the original configuration. Non-concrete joint material damaged by the Contractor shall be restored to the original condition at no additional cost. For steel armor angles which are determined to be in need of repair and upon agreement by the Engineer, the Contractor will propose a method of repair as approved by a Hawaii licensed structural engineer for the Engineer's approval.

Repair of the steel armor angles and anchors will be paid for under "Repair of Joint Armor for overlay areas" by force account. Repair of the concrete behind the angles will be paid for under "Deck Repair".

(P) Over-cut Saw Kerf Groove Filling. If sawing of repair areas extends beyond the corners of the repair areas, then those over-cut grooves shall be filled with a material which is compatible with the replacement concrete and acceptable to the Engineer.

(Q) Surface Testing. The finished bridge deck shall conform to the following requirements when tested by the Contractor in the presence of the Engineer within 14 days following the placement of concrete:

(1) Surface Flatness. The surface of the replaced pavement shall not vary more than 1/8 inch under a 10-foot straightedge placed parallel to or perpendicular to the traffic lanes to within the limits of the repaired area after the repair has cured.

(2) Joint Smoothness. The surface smoothness at the repair edges or joints shall be such that neither side of the joint will vary from a true plane enough to permit a 1/16 inch thick shim 3 inches wide to pass under a one-yard straightedge adjacent to either side of the joint when the straightedge is laid on the pavement perpendicular to joint and its midpoint at the joint.

(3) Surface Elevation. The surface elevation of the repair shall be between 0 and 1/16 inch above the surface as determined by the top elevations of the existing deck slabs that are adjacent to all edges of the repaired deck surface.

(4) Surface Condition. The repaired area shall be sound, free from cracks greater than 0.01 inch in width.

Whenever existing conditions prevent compliance with the above, the Engineer may require testing with priority given in the order listed for the four above items and matching of the surrounding deck as the lowest priority.

(R) Quality Control/Quality Assurance (QC/QA)

(1) Plastic Concrete Sampling and Testing. Perform QC/QA concrete sampling and testing in accordance with the QC/QA and following requirements:

(a) QC/QA tests shall include air content, temperature, slump and preparing compressive strength cylinders for testing at later dates. Perform plastic concrete tests on the initial delivery for each concrete design mix each day. Ensure that QC/QA technicians and laboratory are qualified in accordance with the HDOT'S "Quality Assurance Manual for Materials" dated October 2001. Ensure one technician is present and performing tests throughout the placement operation at each placement site. In any QC/QA plastic properties fail, reject the remainder of the load, terminate the LOT and notify the Engineer. A LOT shall be one days production, once every maximum of 20 cubic yards of concrete or approximately once every 1,000 square feet of repaired area, whichever is least. Cast a set of cylinders representing the LOT of concrete from the same sample of concrete.

(b) Following the termination of a LOT, obtain samples from a new load and perform plastic properties test until such time as water to cementitious material ratio, air content, temperature is in compliance. Initiate a new LOT once the testing indicates compliance.

(c) Maintain a logbook with records of relevant details of all tests. Provide a copy of new entries at the end of each work day to the Engineer. Make available for inspection by the Engineer during the normal working hours of construction. At the end of the project deliver the original logbook to the Engineer. The original logbook will become the property of the Engineer.

(S) Verification and Independent Assurance. The Engineer may perform verification sampling and testing to validate Contractor sampling and testing as well as the quality of the materials produced. Furnish sufficient concrete of each design mix for verification and independent assurance sampling and testing as required by the Engineer. When the Engineer performs verification, the Contactor may perform the same test on the concrete at the same time. HDOT's Independent Assurance program will be conducted to evaluate all sampling and testing used in the acceptance material.

(T) Acceptance.

(1) Sampling and Testing. Sample and test concrete of each mix design for water to cementitious ratio, air content, temperature, slump and cast a set of three cylinders for compressive strength tests once per LOT. A LOT shall be one days production, once every maximum of 20 cubic yards of concrete or approximately once every 1,000 square feet of repaired area, whichever is least. When more than one production facility or continuous volumetric mixer is used for the same mix design, apply the sampling and testing frequency per production facility or per continuous volumetric mixer.

Take these acceptance samples randomly in accordance with ASTM D3665 or as determine by a random number table acceptable to the Engineer. Select and document the selection of random samples(s) prior to the work activity. Include the date and time of determination of the selection.

Provide curing facilities that have the capacity to store cylinder samples for QC and Verification simultaneously for initial curing. Deliver the QC samples to the final curing facility in accordance with AASHTO T 23. At the same time, the Engineer will deliver verification samples to their final curing facility. All cylinders will be clearly identified.

Test the QC laboratory cured samples for compressive strength at the ages of 3 hours, 7 days, and 28 days in a laboratory meeting and maintaining at all times the qualification requirements in the Highways Division's Quality Assurance Manual for Materials. Notify the Engineer of the Quality Control Laboratory compressive test results within 24 hours.

The Engineer will average the QC compressive strengths data, average the Verification compressive strength data and compare the results. Comparison of results can also be on the latest five Verification data and the QC data during the same period. Based on this comparison, the Engineer will determine if the Validation Criteria as shown in the following table has been met.

Strength	Difference
Less than 3500 psi	450 psi
3,501 - 4,500 psi	590 psi
4,501 - 6,500 psi	910 psi
6,501 - 8500 psi	1,275 psi
Greater than 8,500 psi	1,360 psi

When the difference between the QC and Verification are less than or equal to the Validation Criteria, the QC data is validated and the Engineer will use the Contractor's data as a part of the acceptance procedures. When the difference between QC and Verification data exceeds the Validation Criteria, the Engineer will initiate the dispute resolution process requirements of Section V of Highway's Quality Assurance Manual for Materials.

(2) Acceptance of Hardened Concrete. Hardened concrete will be accepted or rejected on the basis of strength tests and any of the requirements or characteristics in Subsection 676.02. Do not discard a cylinder strength test result based on a low strength (strength below the specified minimum strength). The Engineer will accept at full payment only at LOTS of concrete represented by strength test results equal or exceed the respective specified minimum strength. The compressive strength result of the LOT shall meet the specified minimum strengths of 3000 psi at 3 hours* and 6000 psi at 28 days. The Engineer may accept the average compressive strength of three individual test results in lieu of individual strength test result provided that no single test result is less than 90 percent of the average value.

* As determined by the maturity meter readings.

(U) Documentation of Repairs. Include in the preparation of posted drawing as required in Section 648, records of each repaired concrete area.

The documentation shall include the following:

(1) The replacement concrete pour date.

(2) The location of the center of each repair rectangle as indicated by:

(a) The baseline station number.

(b) The transverse offset from the baseline with offset direction information.

(3) The dimensions of the rectangle in the following directions:

(a) Longitudinally in the direction of traffic flow.

(b) Transversely perpendicular to the direction of traffic flow.

(4) Identification of the repair area represented by the maturity sensors and cylinder sample collected or that the test was performed on strength test results of cylinders and maturity meter readings shall be included for all repair areas.

(5) QC/QA and Acceptance test data.

(6) The Contractor shall also prepare a spread sheet tabulation of the above information.

(V) Concrete Sealer. After completing the deck repairs, the entire deck surface (parapet to parapet) of the Inbound and Outbound structures, excluding the Inbound overlay limits as shown in the contract documents, shall receive a 100% silane concrete sealer containing migrating corrosion inhibitors that are amine carboxylate based dipole corrosion inhibitors. The roadway surface texture and friction shall remain unchanged after application of the sealer. The installed sealer shall be compatible with a polyester concrete overlay which will be installed in a future project.

The polyester overlay will utilize a methacrylate resin prime coat and a polyester concrete consisting of a polyester resin binder and dry aggregate.

(W) Post-Construction Survey, Sealing Cracks and Repairing Delaminations. Perform a post-construction survey with the Engineer present three months after replacement concrete placement except survey for overlay areas shall be conducted prior to overlay operations. Contractor shall survey all concrete repairs in accordance with ASTM D4580 including visual inspections for cracks and other defects in the presence of the Engineer. Seal cracks that are greater than 0.01 inch in width with epoxy materials which are compatible with the repair concrete and acceptable to the Engineer. Replace unacceptable areas with replacement concrete as specified in this section at no increase in contract time or contract price. Repaired areas will be subject to re-inspection. Provide documents of the post construction surveys that are acceptable to the Engineer.

(X) Areas of Work. The areas of work for deck repair shall be on the Interstate Route Eastbound direction including all the Eastbound On and Off Ramps and the Westbound direction including all the Westbound On and Off Ramps.

The deck within the overlay area specified in Section 677 – Polyester Concrete Overlay, shall be repaired first.

The Concrete Sealer shall be applied to all deck surfaces within the project limits except within the overlay limits.

(Y) Permanent and Temporary Pavement Markings. Permanent and Temporary pavement markings that are damaged or missing within the daily area of work shall be installed or replaced prior to the close of day. Permanent pavement markings shall be installed within 30 days after completion of the deck repaired areas. This work shall conform to Section 629 - Pavement Markings, Subsections 629.01 thru 629.03.

676.04 Measurement.

(A) The Engineer will measure the Deck Repair per square foot in accordance with the contract documents.

(B) Concrete sealer will be paid for on a lump sum basis. Measurement for payment will not apply.

(C) Repair of Joint Armor will be paid for on a Force Account basis. Measurement for payment will not apply.

(D) The Engineer will not measure for Permanent and Temporary Pavement Markings for payment.

676.05 Payment. The Engineer will pay for accepted pay items listed below at the contract price per unit, as shown in the proposal schedule. Payment will be full compensation for the work prescribed in this section and the contract documents.

The Engineer will pay for the following items:

Pay Item	**Pay Unit**
Repair of Joint Armor for Overlay Areas	Force Account
Concrete Sealer, _____	Lump Sum
Deck Repair _____	Square Foot

(1) 60% of the contract bid price upon completion of the Subsections; 676.03(A) - Submittal Requirements, 676.03(F) - Pre-Operational Demonstration, 676.03(H) - Deck Condition Survey, 676.03(I) - Preparation of Repair Areas, 676.03(J) - Traffic and Equipment Control on Bridge, 676.03(K) - Placement of Replacement Concrete, 676.03(L) - Consolidation, 676.03(M) - Finishing, 676.03(N) - Protection and Curing, 676.03(0) - Joints, 676.03(P) - Over-cut Saw Kerf Groove Filling, 676.03(Y) - Permanent and Temporary Pavement Markings, and any other steps required to repair the deck, but not including testing and inspections paid for below.

(2) 30% of the contract bid price upon completion of Subsection 676.03(Q) - Surface Testing.

(3) 10% of the contract bid price upon completion of Subsection 676.03(W) - Post-Construction Survey, Sealing Cracks, Repairing Delaminations, and completion of all permanent pavement markings.

Subsections 676.03(B) - Early Strength Monitoring, 676.03(C) - Continuous Volumetric Concrete Mixers, 676.03 (D) - Just-in-Time Training, 676.03 (E) - Pre-Operational Conference, 676.03(R) - Quality Control/Quality Assurance (QC/QA) and 676.03(T) - Acceptance; will not be paid for separately and will be considered incidental to the various pay items in this Section. All documentation required in this Section, including that is required in Subsection 676.03(U) - Documentation of Repairs will be paid for under Contract Item No. 648.0100 - Field-Posted Drawings.

Documentation of test results regarding logbook and test records, which do not use the Field-Posted Drawings, will be paid for under item (3) 10% of the contract bid price upon completion of Post Construction Survey, Sealing Cracks, and Repairing Delaminations.

Subsection 676.03 (I) (2) - Corroded Reinforcing Steel will not be paid for separately since this work shall be included in the contract prices of the various contract pay items in this Section.

The Engineer will not pay for Permanent and Temporary Pavement Markings separately. The Engineer will consider the cost as included in the various contract pay items in this Section."

END OF SECTION 676