Make the following Section a part of the Standard Specifications:

"SECTION 680 – DEFECTIVE CONCRETE REPAIRS

680.01 Description. This section is for the repair of all concrete spalls, delaminations, honeycombing, and other defective concrete. This section applies to the locations as designated on the plans as well as all other locations encountered by the Contractor.

680.02 Materials. The Contractor shall use a polymer modified repair material of which shall herein be referred to as a "repair material."

(A) Polymer Modified Repair Material:

(1) A factory blended cementitious patching material (containing no gypsum) combined with a polymer type admixture, water, and a corrosion inhibitor. The 3 hour and 28-day compressive strength shall be at least 3,000 psi and 6,000 psi respectively. The 3-hour bond strengths shall be at least 250 psi respectively. The repair material must be able to bond to itself achieving the minimum bond strength of 250 psi.

(2) Materials shall consist of:

(a) Western Materials FASTRAC 246 Concrete or approved equal

(b) Western Materials Ready-To-Use FASTRAC Polymer or approved equal

(c) 1½ pints per cubic yard of CORTEC MCI 2005 NS or approved equal

(B) Water. Potable.

(C) Curing Compound. For curing of polymer modified repair concrete and mortars, apply curing as recommended by the repair mortar manufacturer.

(D) Other Materials: Other Materials: All other materials, not specifically described but required for the successful completion and installation of the work shall be selected by the Contractor and shall be compatible with all material it is combined with. All material and potential interaction of the material with others used shall be submitted to the Engineer for acceptance.

(E) Substitution of Materials.

(1) Use only materials specified herein. Other materials of the

same manufacturer or of other manufacturers may not be substituted for those specified without submitting a request with information about the material and obtaining written acceptance from the Engineer. This is not to be construed as to limit competition but to establish a minimum standard of quality. Other manufacturers products of equal or better system of products will be considered as a substitution to the system of products specified herein. However, complete documentation proving that the substituted product meets or exceeds the performance of the specified product shall be provided in order to provide a basis for evaluation and comparison. Submission of incomplete, inadequate, incongruous, vague material and installation data will be grounds for rejection without review.

(F) Mandatory pre-construction meeting.

(1) Prior to the start of work, but no later than 3 days prior, the Contractor shall attend an on-site pre-construction meeting to discuss construction procedures, timelines, and contract requirements. Required attendees should be HDOT, Contractor, Designer of Record, and material manufacturer's representative.

No pre-construction meeting shall be held until all material submittals, material samples and required documentation related to this Section have been submitted and accepted by the Engineer. Work related to this Section shall not start until the pre-construction meeting has been successfully held and completed.

680.03 Construction.

(A) Submittals.

(1) Material Safety Data Sheets: Furnish the manufacturer's Material Safety Data Sheets for each of the materials present at any time on the job site.

(2) Manufacturer's data sheets and certificates of compliance signed by the manufacturer for the following:

(a) Pre-packaged polymer modified repair material.

(b) Ready-to-use liquid polymer admixture.

(c) Corrosion inhibitor.

(d) Materials for curing repair material.

(e) Equipment: Submit descriptive literature describing the kinds, types, model numbers and operational features of the mixing and application proposed for use on this project.

(3) Mix design describing the actual proportions that the Contractor plans on mixing the material in the field. Consult manufacturer on material proportions to obtain optimal mix design.

(4) Three specimens per test age will be prepared and tested by the Contractor and tested in the presence of the Engineer for each day's work or each construction stage of work, whichever is more in accordance with ASTM C39. These test ages are 3 hours, 7-days, and 28-days. The Contractor should not consider this item in their bid price.

(B) Quality Assurance.

(1) The Contractor shall be experienced (5 years or more) and have expertise in the field of repairs of reinforced concrete structures, proper application of corrosion inhibiting admixtures, and be familiar with the type of repair mortar specified for this project. The Contractor will employ and provide a full-time supervisor to be on site at all times during the duration of the work covered in this Section. This person will work very closely with the manufacturer of the repair systems, the Engineer and the State's representative.

(2) Codes and Standards: Comply with all locally applicable codes, regulations and requirements pertaining to this work.

(3) Rejection of Installed Work: The Engineer shall have the right to reject all work which is not in compliance with the requirements of the Contract Documents.

(4) Indication of lack of skill on the part of installation, application mechanics, QA performance, etc., will be sufficient grounds for the Engineer to reject applied products and to require their immediate removal and complete reinstallation and application until the Engineer accepts the work. The Engineer may require the replacement of the QA personnel and equipment if it feels it is needed. All actions and the resultant impacts shall be at no additional cost to the State and additional contract time.

(5) Replacement of rejected work may require that the materials in places be stripped back to solid substrate and that special additional surface preparation and a change of surface preparation or primer or repair materials may be required. The Contractor shall research and define these procedures and complete the additional

surface preparation and reapplication of the repair materials at no extra cost to the State.

(C) Delivery, Handling, and Storage.

(1) Delivery of Materials: Deliver all materials in original tightly sealed containers or unopened packages, clearly labeled and containing manufacturer's name, labels, date of manufacture, lot number, product identification, manufacturer's instructions for mixing, and warning for handling and toxicity.

(2) Storage: Store materials at the Contractor's place of business in cool, dry and safe location out of weather in original containers or unopened packages as recommended by the manufacturer. Temperature and humidity requirements of the manufacturer are to be adhered to at all times. No debris shall be allowed other than material debris created during the shift.

(3) Handling: Handle all materials in a safe manner and in a way to avoid breaking container seals.

(4) Environmental Requirements: Container shall comply with manufacturer's recommendations as to environmental conditions under which the materials may be applied.

(D) Job Conditions.

(1) Adhere to the manufacturer's printed instructions regarding weather and climate condition restrictions on the use of all materials supplied in this section.

(2) Do not apply the materials if it is raining or if rain is imminent. Take proper precautions to protect newly placed and completed repairs from weather conditions such as strong wind, rain, or high ambient temperatures.

(3) Do not man scaffolds or lift equipment in wind or rain conditions that makes working dangerous.

(4) Protection: Precautions shall be taken to avoid damage to any surface near the work area due to spillage.

(5) Barricades: Erect temporary barricades and railings, to prevent people from entering the project area. Coordinate with the State’s representative on final location and placement. The extent of barricade and railings may be adjusted by HIOSH requirements at no extra cost to the State.

(E) Protection of the Work. Use all means necessary to protect the materials of this section before, during and after installation and to protect

this work and the work of all other trades. In the event of damage, immediately make repairs and replacements necessary to the approval of the State's representative at no additional cost to the State.

(F) Early Strength Monitoring. Provide a minimum of two sacrificial sensor type maturity meters meeting the requirements of ASTM C1074 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, 75ºF, 100ºF, 125ºF, 150ºF and 175ºF. The temperature recording device shall be accurate to within ± 2ºF.

Develop strength-maturity relationship using only maturity meters, materials and conditions to be used or encountered on the project for Polymer Modified Repair Mortar prior to placing any Polymer Modified Repair Mortar 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 C 1074 Estimating Concrete Strength by the Maturity Method at the Polymer Modified Repair Mortar producer's laboratory or other approved laboratory facilities. For every Polymer Modified Repair Mortar design, prepare a minimum size of each batch of Polymer Modified Repair Mortar of at least one cubic yard and cast a minimum of 15 cylinders in accordance with AASHTO T23. Test three cylinders at ages of 3, 4, 6, 12, and 24 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 Polymer Modified Repair Mortar on the project.

(1) Project number, Polymer Modified Repair Mortar mix number and test date.

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

VESLMC.

(3) Type and amount of admixtures used in the batch of Polymer Modified Repair Mortar.

(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 C 1074.

Provide a minimum of two maturity meters at the project site for monitoring the early strength of Polymer Modified Repair Mortar during each section of Polymer Modified Repair Mortar 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 Polymer Modified Repair Mortar placement such that there is a minimum of one sensor in each half of the length of the deck slab to be poured. Place sensors no closer than 4 inches from any formed surface or edge of slab being placed. Modify means and methods subsequent to failures of sensors to prevent any reoccurrence. The Engineer may designate location of maturity meter sensors.

Conduct a validation test after each day of Polymer Modified Repair Mortar placement 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 Polymer Modified Repair Mortar 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 Engineer will not accept Polymer Modified Repair Material which does not meet the compressive Polymer Modified Repair Material strength of 3,000 pounds per square inch at 3 hours as determined by the maturity meter readings.

(G) Execution.

(1) All repairs shall be made in accordance with the appropriate Repair Application Procedures (RAP) publications by the American Concrete Institute (ACI) and recommendations by the International Concrete Repair Institute (ICRI).

(2) The Contractor shall inspect all concrete deck and soffit surfaces for the bridge span in question (Abutment to Pier) and all concrete surfaces surrounding the repair area for spalling and/or other deterioration. Inspection shall include a visual inspection, an auditory hammer sounding, and exploratory removal methods. Areas identified for repair shall be marked on the surface, and marked on the project as-built plans.

(3) Defective Concrete Removal:

(a) General: Execute all work in an orderly and careful manner. Protect all surfaces and items to remain. The Contractor is responsible for any and all damages, repairs or replacement of existing surfaces and items to remain. Carefully cut and remove defective materials indicated or found without damaging adjacent material surfaces or items that are to remain. Provide catchment device or platform to collect all concrete chips and other debris for proper disposal offsite.

(b) Where concrete work is to be repaired, make a 1/2 – inch deep square saw cut along straight lines at 90-degree angles, 1 inch beyond the edge of the damaged area or spall into sound concrete, unless noted otherwise. Use a 15-lb. chipping hammer or smaller hand tools to produce the remainder of the 1- inch deep square cut. When a saw-cut edge cannot be achieved because of tool interferences, face of the top edge of the patch shall be chipped out to provide a vertical face a minimum of 1/2-inch to 3/4-inch depth, unless shown otherwise. The remainder of the defective concrete shall be chipped out with a chipping gun to solid sound concrete. Adjust saw-cut depth so as not to cut existing concealed reinforcing bars or PT ducts. Do not extend saw-cut beyond the limits of field removal work.

(c) Spalled and Loose Surfaces: Remove all loose concrete and check all spalled areas that are indicated or are obvious upon visual examination.

(d) Sounding: Inspect the remaining exterior concrete surfaces around the repair area and between the abutment and pier for the bridge span in question for any other defective concrete by tapping with a hammer throughout the exterior surface of the area around the repair and listening for dull or hollow sounds. In areas where tapping does not produce a solid tone, remove loose and spalled concrete until testing produces a solid tone. Use a high frequency chipping hammer to deepen cavity.

(e) Partially exposed reinforcing bar(s) exposed when prying and chipping off concrete shall be fully exposed throughout its length, within the patch area. There shall be a minimum of 1-inch of space between the reinforcing bars and the concrete.

(f) Remove deteriorated concrete, prepare and clean surfaces to be patched. Clean all chipped concrete surfaces to remove all foreign material and laitance before application of repair material or placement of formwork for cast-in-place concrete repairs. Do not remove more than 50% depth of the structural member (e.g. deck, girders, etc.). Notify the Engineer if unsound concrete still remains. Do not place repair material if unsound concrete still remains.

(g) All concrete surfaces to receive repair material shall be roughened to ¼ inch amplitude.

(4) Surface Preparation:

(a) Cleaning: After removal of all defective concrete, remaining concrete surfaces to be patched shall be structurally sound, clean, free of dirt, powdered concrete, loose mortar particles, paint, film, protective coatings, efflorescence, laitance, and other matter detrimental to proper adhesion of the new repair material. Work surfaces must be free of ridges, fins or sharp projections. All reinforcing bars in the repair area shall be made free of all concrete, scale and loose rust by using either powered rotary wire bristle brush or abrasive blasting. Needle gunning may be used as preliminary step for removal of

loose rust. Following all concrete removal and steel cleaning, the entire repair area shall be cleaned. Any areas not patched within 48 hours after cleaning shall be recleaned.

(i) Immediately prior to placing repair material, the repair area shall be cleaned of all dust and debris with high-pressure, oil-free compressed air at a minimum of 100 psi using an OSHA compliant air blow gun nozzle with extension.

(ii) Certify that all of the manufacturer's recommendations for preparation, bonding and application have been followed.

(5) Formwork: All formwork, supports, and bracing shall be adequately designed to support the anticipated weight of the wet repair material. Caulk all edges to ensure forms are watertight. Set elevation of formwork such that the minimum concrete clear cover, as shown in the drawings, is provided.

(a) No sooner than 90 minutes prior to placement of repair material, flood formwork with clean water until full. Hold water in formwork for 1 hour to ensure that formwork is watertight. Drain formwork so that the concrete surface is saturated surface dry. Remove loose materials and other debris within the formwork. Ensure drain holes are closed and water tight.

(6) Application of Repair Materials:

(a) Repair material manufacturer’s representative shall be present for initial repair and as necessary to ensure proper preparation and application techniques are being utilized.

(b) Mix repair material and apply in strict conformance with the manufacturer's published instructions or job specific written instructions. If patch exceeds maximum thickness, extend with aggregate as recommended by manufacturer.

(c) Make batches large enough to assure continued placement of repair material within repair area prior to initial set. No cold joints in the vicinity of the repair will be allowed.

(d) Finish: Finish all patch work to match existing surfaces in texture and appearance or as otherwise directed by the State's representative. Do not feather edge repair material onto adjacent surfaces. Grind any high spots, transition areas, or protrusions.

(e) Curing:

(i) Allow repair material to cure for a minimum 3-hours prior to opening to traffic.

(ii) Immediately following formwork removal, apply curing compound to all repaired surfaces. Curing compound shall be a Lithium based product as recommended by the repair mortar manufacturer.

(7) Field Quality Control: The Contractor's representative will conduct field trials to verify compressive strength.

(a) Sampling: The Contractor's representative will prepare cylindrical concrete specimens for compressive strength testing by an independent testing laboratory.

(b) Testing: The Contractor's representative will perform compressive strength tests on cylinders by an accredited testing laboratory. If the compressive strength test results fail to meet the specified requirements after two tests, the repairs made using the batched material represented by the samples tested shall be rejected. Areas of rejected repairs shall be removed, replaced and re-tested until acceptable at no additional cost to the State.

(c) Special Inspection:

(i) The State's representative will examine the repair materials at the job site just prior to use to verify that the materials used at the jobsite are the selected and approved materials referenced in the test results of design mixes or certificates of compliance submittal.

(ii) The State's representative will examine the surface preparations, mixing, application and curing procedures of the repair materials to determine conformance with the requirements specified.

(d) In-Place Test of Repairs:

(i) The State's representative, utilizing a 2-pound hammer, will test all completed concrete spall repairs to locate hollow or ringing sounding areas. A hollow sound generally will indicate that either the repair material has not completely filled the space from which the damaged concrete was removed or that it has not adequately bonded to the concrete substrate. Sounding of the repair area shall take place no sooner than 30 days after the completion of the repair and in the presence of the Engineer.

(ii) The Contractor shall remove the repair material from those hollow or ringing sounding areas, prepare the surfaces of the exposed reinforcing bars and the sound concrete substrate, if necessary, form and then place, cure and finish the new repair materials at no additional cost to the State and no additional contract time. Upon completion, the repairs will be retested by the State's representative.

(8) Cleaning:

(a) Surfaces Not Involved in the Repairs: Adjacent surfaces damaged by staining left by concrete work, or other concrete materials shall be completely restored to the original new condition with respect to color and texture to the acceptance by the State's representative.

(b) Uncured polymer-modified repair material can be cleaned from tools with water. Cured polymer- modified repair material can only be removed mechanically.

(c) Removal:

(i) Remove debris and rubbish from the site daily. Prevent debris and rubbish from entering the waterway. Debris and rubbish shall not be allowed to accumulate on the site. Debris shall be removed and transported in a manner that will prevent spillage into the open channel, onto the adjacent ground and streets.

(ii) Upon completion of the work, remove all materials, tools, forming materials, catchments, work

platforms, refuse and debris generated by the work specified in this section.

(H) Traffic, Equipment, and Material Control on Bridge.

(1) Construction vehicles shall not exceed a 5-mph speed limit within 200 feet of the placement area in both directions during Polymer Modified Repair Mortar placement and curing.

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

(3) The Contractor shall not permit compressors or other equipment that produce vibrations on the span undergoing deck Polymer Modified Repair Mortar work. Equipment shall not be located on spans undergoing deck Polymer Modified Repair Mortar unless approved by the Engineer.

(4) Vehicular traffic shall not exceed a 35-mph speed limit on the bridge span during Polymer Modified Repair Mortar pour and cure.

(5) The Polymer Modified Repair Mortar shall have a minimum compressive strength of 3000 psi as determined by Early Strength Monitoring and by testing according to manufacturer's recommendations prior to opening to traffic.

(6) The bridge deck shall not be used as a storage area for equipment or for stockpiling materials. Loads exceeding eight tons shall not be used on the bridge unless approved by the Engineer.

(7) The contractor shall not allow any equipment or vehicles within 4 feet laterally from any repair for the duration of traffic control.

(8) No debris or material shall be stored on the bridge being repaired. Analyze the bridge's construction loading by a Hawaii licensed Structural Engineer to determine acceptable loading of the bridge during demolition and construction. Submit stamped and sign analysis document to the Engineer.

(I) Acceptance. Hardened concrete will be accepted or rejected on the basis of strength tests and sounding methods. Do not discard a cylinder strength test result based on a low strength (strength below the specified minimum strength). When QC strength test results are verified, 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 results 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.

(J) 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.

(K) Post-Construction Survey, Sealing Cracks and Repairing Delaminations. Perform a post-construction survey with the Engineer present between three and nine months, or prior to opening the structure.

Contractor shall survey all 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 materials and acceptable to the Engineer. Remedy, remove, or replace unacceptable areas with Polymer Modified Repair Material 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.

680.04 Measurement. The Engineer will measure the Defective Concrete Repair per square foot of repaired and accepted section.

The Engineer will measure Additional Defective Concrete Repairs on a force account basis according to Subsection 109.06 - Force Account Provisions and Compensation and as ordered by the Engineer.

680.05 Payment. The Engineer will pay for the accepted quantities of Defective Concrete Repair at the contract unit price per square foot, complete in place.

The payment will be full compensation for chipping, removing and disposing of defective concrete found within the limits of the spall and patch repair work; locating existing reinforcing steel bars, extending the probing to beyond the end of corrosion and removing concrete around the corroded reinforcing steel; cleaning and preparing concrete surfaces; removing corrosion damage from reinforcing steel; providing forms and falsework; placing, finishing and curing concrete repair materials; repairing defects; sampling and testing concrete; for clean-up; and for furnishing equipment, tools, labor, materials and other incidentals necessary to complete the work.

The Engineer will pay for the accepted Additional Concrete Repairs on a force account basis according to Subsection 109.06 - Force Account Provisions and Compensation. An estimated amount for the force account is allocated in the proposal schedule under Defective Concrete Repairs, but the actual amount to be paid will be the sum shown on the accepted force account records, whether this sum be more or less than the estimated amount allocated in the proposal schedule.

Payment will be full compensation for the work prescribed in this section, by the Engineer, and in Subsection 109.06 - Force Account Provisions and Compensation.

Pay Item	**Pay Unit**
Defective Concrete Repairs _____	Square Foot
Additional Defective Concrete Repairs	Force Account”

END OF SECTION 680