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. Depending on the location of the repair, the Contractor shall use a polymer modified repair mortar of which shall herein be referred to as a "repair material."

(A) Polymer Modified Repair Mortar (For Underside of Bridge Repair):

(1) A factory blended cementitious patching material (containing no gypsum) combined with a polymer type admixture, water, and a penetrating corrosion inhibitor. The 7-day and 28-day compressive strength shall be at least 5,000 psi and 6,000 psi respectively. The 28-day permeability shall be <1,000 Coulombs per ASTM C1202, and the 28-day bond strength shall be 1,500 psi per ASTM C882. The polymer type admixture shall be added to the mixing water. The ratio of polymer solids to cement weight shall not be less than 10 percent.

(2) Acceptable Materials:

(a) Duraltop Gel, The Euclid Chemical Company

(b) SikaTop 123 PLUS, Sika Corp.

(B) Bonding Agent.

(1) A three component, preproportioned, water based epoxy modified Portland cement bonding agent and anti-corrosion coating designed to bond fresh concrete to existing concrete. ASTM C882 Bond strength shall exceed 2400 psi at 14 days.

(2) Acceptable Materials:

(a) Duralprep AC, The Euclid Chemical Company

(b) Sika Armatec 110 EpoCem, Sika Corp.

(C) Water. Potable.

(D) Curing Compound. For curing of polymer modified repair

concrete and mortars, apply Sinak Lithium Cure 1000 curing com pound at a coverage rate of no more than 200 ft^2 per gallon. For curing concrete that will receive surface sealers, apply impervious sheeting, ASTM C171, or check with the manufacturer of the surface treatments on the recommended method of curing.

(E) Other Materials: All other materials, not specifically described but required for the successful completion and installation of the work shall be as selected by the Contractor, subject to the acceptance of the Engineer.

(F) 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 written approval of the Engineer. This is not to be construed as to limit competition but to establish a standard of quality. Other manufacturers of equal or better system of products may 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 disapproval without review.

(2) Substantiation: For substitution requests, submit documentation from the manufacturer's home office since claims by field sales and products representatives are not recognized by the parent company should a claim be inaccurate.

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) Bonding agent and anti-corrosion coating for reinforcing steel bars.

(b) Pre-packaged polymer modified repair mortar which contains a penetrating corrosion inhibitor.

(c) Materials for curing repair concrete and mortars.

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

(3) Three specimen per test age shall be prepared and tested in accordance with ASTM C109. These test ages are 7-days and 28-days.

(B) Quality Assurance.

(1) The Contractor shall be experienced (5 years or more) and have expertise in the field of spall repairs of reinforced concrete structures, proper application of migrating corrosion inhibiting admixtures and protective coatings, and be familiar with the materials, repair and protection systems specified for this project. The manufacturers of the repair and protection systems shall be members in good standing of the International Concrete Repair Institute (ICRI). 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 drawings and specifications.

(a) Indication of lack of skill on the part of installation and application mechanics shall be sufficient grounds for the Engineer to reject applied products and to require their immediate removal and complete reinstallation and application at no additional cost to the State. Mechanics lacking skill shall be replaced.

(b) 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 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.

(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 or rain.

(3) Do not man scaffolds or lift equipment in strong 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 Sate’s representative on final location and placement. The extent of barricade and railings may be adjusted by HIOSHA 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 Sate’s representative at no additional cost to the State.

(F) Execution.

(1) All repairs shall be made in accordance with the appropriate repair application procedures (RAP) publications by the American Concrete Institute (ACI).

(2) The Contractor shall inspect all concrete surfaces around the repair area for spalling and/or other deterioration by 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 inches beyond the edge of the damaged area or spall into sound concrete, unless noted otherwise. Use a chipping gun 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. Do not extend saw-cut beyond the limits of 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 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 top of the existing concrete. Remove enough concrete to force reinforcing bar back away from the finished exterior face of the structure.

(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.

(g) All concrete surfaces to receive repair material shall be roughened to obtain a concrete surface profile equal to CSP 6-8 in accordance with International Concrete Repair Institute (ICRI) guidelines 310.2 to ensure proper adhesion with repair material.

(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 patch materials. Work surfaces must be free of ridges, fins or sharp projections. All reinforcing bars in the repair area shall be needle gunned to remove all scale and loose rust. Any areas not patched within 48 hours after needle gunning shall be recleaned. Contractor shall inform Engineer if more than 25% of the area of the reinforcing steel has been lost due to corrosion.

(i) Immediately prior to placement of bonding agent and 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. Patch area shall be washed with clean water so that

exposed concrete surface is saturated, but with no water accumulation on the surface.

(ii) Prior to applying repair material, follow manufacturer's recommendations for preparation, bonding and application.

(5) Application of Bonding Agent:

(a) All exposed steel and concrete shall be coated with bonding agent. The coating shall be complete with no skips, pin holes or holidays around the entire surface of the exposed steel and concrete. Apply the appropriate number of coats as recommended by the manufacturer. Adhere to manufacturer’s requirements for drying time and open time when applying subsequent coats and repair material.

(6) Application of Repair Materials (Not Requiring Formwork):

(a) Repair material manufacturer’s representative shall be present for initial repair 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 lift thickness, extend with aggregate as recommended by manufacturer.

(c) Make batches small enough to assure placement before binder sets.

(d) For all hand, trowel placed vertical and overhead repair areas, apply repair material in layers as recommended by the manufacturer not exceeding maximum lift thickness. Work and press mortar onto the prepared substrate surfaces to ensure bond. For repair areas that require multiple lifts, the top surface of each lift must be roughened to create a mechanical bond for the following layer of repair material. All layers for each patch shall be placed on the same day. There shall be no cold joints in the field of the repair. Use vibratory floats, plates, or hand tampers to consolidate the patching material layers. Level each layer and screed the final surface unless a built-up section is required to maintain 1 inch minimum concrete cover. Remove excess patching material on the adjacent surfaces before it hardens.

(e) Finish: If fiber reinforced polymer composite is to be bonded to surface of patch material, contractor shall finish material with a concrete surface profile (CSP) in accordance with Section 577 Fiber Reinforced Polymer (FRP) System. Otherwise, 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.

(f) Curing:

(i) Immediately after the final layer of repair material has been placed and finished, curing shall begin.

(ii) Cure according to 680.02.D.

(g) Do not apply FRP to surface of newly placed repair material sooner than 14 days.

(7) Field Quality Control:

(a) Sampling: As soon as the repair materials are batched, sample each batch for testing by an independent testing laboratory. Clearly identify each sample by description of patch material, batch number, intended repair location and quantity batched.

(b) Testing: Perform compressive strength tests on samples by an independent 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. Submit a copy of the test results to the State's representative.

(c) Special Inspection:

(i) The State's representative will examine the repair materials at the job site 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.

(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.

(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. 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 original condition with respect to color and texture to the acceptance by the State's representative.

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

(c) Removal:

(i) Remove debris and rubbish from the site daily. Prevent debris and rubbish from entering the Stream. 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.

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

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; replacing any necessary reinforcing steel; coating the reinforcing steel and prepared concrete surfaces with a corrosion inhibitor epoxy bonding agent; 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.

Pay Item	**Pay Unit**
Defective Concrete Repairs	Square Feet”

END OF SECTION 680