Make the following Section a part of the Standard Specifications:

"SECTION 694 – CRACK REPAIR BY EPOXY INJECTION

694.01 Description. This work includes the repair of cracks in concrete by pressure-injecting epoxy into cracks that intersect at least one accessible surface of the concrete or masonry member. It does not cover the repair of delaminations where the intersection of the cracked concrete with the surface of the concrete member is not accessible nor can be made accessible.

694.02 Materials.

(A) General. Deliver all injection adhesives to the job site in sealed containers with labels intact. Store all injection adhesives between 4 and 32°C (40 and 90°F) unless otherwise specified by the manufacturer.

(B) Surface Seal. Use the materials to seal the crack faces that have the strength and adhesion to contain the injection adhesive in the crack during the injection process and while the injection adhesive cures, and, if required to be removed, shall not leave a residue or damage the surfaces.

(C) Injection Adhesives. Injection adhesives for cracks that can be sealed on all faces – Use an adhesive that conforms to the requirements of ASTM C 881/C 881M, Type IV, Grade 1, and any additional requirements as defined in the Project Specifications.

If all faces of the crack cannot be reached to apply a surface seal, use an injection adhesive that conforms to the requirements of ASTM C 881/C 881M, Type IV, Grades 1, 2, or 3, and has a viscosity that will allow it to achieve and maintain the penetration requirements specified in Subsection 694.03H(1) – Acceptance Criteria.

694.03 Construction.

(A) Submittals.

(1) Qualification testing – Submit an independent laboratory test report, including all test results, certifying that the injection adhesive meets all the requirements specified in Subsection 694.02(C) – Injection Adhesives.

(2) Manufacturer's certification – Submit the manufacturer's certification verifying conformance to the requirements of Subsection 694.02(C) – Injection Adhesives, of each lot of injection adhesive to be used in the Work.

(3) Additional testing – Submit additional test results when required.

(B) Quality Assurance.

(1) Metering Accuracy. Use equipment or tools for continuous (metering) or batch proportioning for the two components of the injection adhesive that are able to establish and maintain a ratio of the components within the tolerance specified by the manufacturer of the injection adhesive over the full range of operating pressures and temperatures. If the manufacturer of the adhesive does not specify a tolerance for the mixture ratio, maintain a mixture ratio within ±3% of the nominal mixture ratio specified by the manufacturer of the adhesive.

(2) Qualification Test for Metering Accuracy.

(a) When a continuous metering and mixing pump is required, test the metering accuracy of equipment before the start of the Work to demonstrate that the pump is capable of maintaining the ratio within the tolerances required in Subsection 694.03(B)(1) – Metering Accuracy.

(1) Conduct the test using a pump discharge pressure that ranges from the lowest to the highest discharge pressure at which the equipment is expected to be operated during the injection process.

(2) The device used to measure metering accuracy shall be capable of controlling the discharge pressure of each of the components separately as they are simultaneously discharged into separate containers.

(3) Conduct one test by discharging both adhesive components simultaneously into separate containers while maintaining a discharge pressure on both components equal to the lowest operating discharge pressure. Conduct a second test at the highest operating discharge pressure.

(4) Measure injection pressure with a gauge mounted upstream of and within 300 mm (12 in.) of the mixing chamber.

(5) Discharge a minimum of 200 g (7 oz) of each component into separate graduated containers or into containers that can be weighed. If the ratio determination is made by mass, the volumetric ratio may be determined by calculation using the specific gravity of each component. (The volumetric ratio is determined by multiplying the mass ratio by the inverse of the ratio of the specific gravities of the components.)

(b) Demonstrate that the injection equipment does not have more than a 35 kPa (5 psi) drop in pressure in either of the two component lines after operating with no flow for 3 minutes with at least 80% or more of the operating pressure.

(C) Qualification Tests for Mixing Effectiveness of Equipment. Before the start of the test injection Work, conduct the bond strength 2-day cure and compressive yield and compressive modulus tests in ASTM C 881/C 881M on the specified injection adhesive processed with the equipment and tools to be used to meter, and mix the injection adhesive in the Work. If the test results do not meet the requirements of ASTM C 881/C 881M, modify or replace the equipment.

(D) Qualification of Injection Procedures. As the first item of Work, repair a test crack selected by the Engineer not less than 3.0 m (10 ft) in total length. If there are no cracks at least 3.0 m (10 ft) in length, the Engineer will select a number of shorter cracks whose total length will approximately equal 3.0 m (10 ft). Inject the test crack(s) using the specified injection adhesive. Use the same surface seal, equipment, and application methods that are to be used in executing the Work. Do not begin the remaining injection work until the equipment and application methods are accepted.

(E) Quality Control

(1) Metering Accuracy Tests for Continuous Mixing. The first time any piece of two-component continuous metering and mixing equipment is used in the Work and any time each piece of equipment is used in the Work and any time each piece of equipment is used after a 4-hour or longer shutdown period, test two-component continuous metering and mixing equipment to demonstrate that the equipment is operating as required. If the ratio of the two components is not within the specified tolerance, stop injection work until the equipment is brought into compliance with Subsection 694.03(B)(1) – Metering Accuracy. Maintain a record of all such tests and temperature of each adhesive

component. Submit the record to the Engineer at the end of each workday.

(2) Metering Accuracy Test for Batch Mixing. For every batch of adhesive mixed, record the amount of each component and the total amount of mixed adhesive within ±3%. Maintain a record of all batches, including date, time, and mixture ratio.

(F) Evaluation and Preparation

(1) Crack Width. Inspect all cracks to determine if they are within the scope described in the Project Specifications. When required, measure the width of the crack to make this determination, and make the measurement at the time of day when the cracks are at their widest as measured at the surface of the concrete member. Submit to the Engineer a list of crack widths and lengths of all cracks greater than 0.01 inches. All cracks 0.01 inches or larger shall be repaired when approved by the Engineer.

(2) Crack Movement. If the width of a crack changes because of daily temperature cycles or other external loading of the structure, inject the crack when it is at its widest.

(3) Crack Preparation.

(a) Remove foreign material, such as dirt, oil, grease, or other chemicals, from the cracks before injection.

(b) Water in Cracks. Unless the crack is in submerged concrete, remove any water that can be seen by visual inspection from the cracks before the injection process, and remove water that appears during the injection process.

(c) Temperature of the Concrete. Do not inject adhesive if the temperature of the concrete is not within the range of application temperatures recommended by the manufacturer of the adhesive.

(4) Test Injection. After the test crack(s) has (have) been prepared, conduct the test injection specified in Subsection 694.03(D) – Qualification of Injection Procedures. If results do not meet the requirements of the contract documents, modify crack preparation and injection procedures, as approved, until satisfactory results can be obtained.

(5) Surface Sealing. Apply a surface seal over all exterior faces of the crack that can be reached to contain the injection adhesive in the crack.

(6) Injection. Inject cracks so that the requirements of the contract documents are met.

(7) Cleanup

(a) Surface Seal and Ports. Remove surface seal and any installed injection ports that protrude from the surface of the concrete.

(b) Spills and Leaks. Clean and remove all spills and leaks of injection adhesive and stains caused by the injection adhesives.

(G) Daily Log. Maintain a written daily log for each day of injection work that includes:

(1) Ambient temperatures at the start and end of the workday and 4 hours after the end of the workday;

(2) Weather conditions, such as rain, and wind, including changes during the shift;

(3) Crack cleaning methods, if any, including locations,

(4) Record of injection adhesive, including manufacturer, product and batch number, and amount used each day; and

(5) Signature and printed name of person responsible for record keeping.

Submit the log to the Engineer each workday.

694.04 Measurement. The Engineer will measure crack repair by epoxy injection per linear foot according to the dimensions shown in the contract documents or as ordered by the Engineer.

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

694.05 Payment. The Engineer will pay for the accepted crack repair by epoxy injection by the linear foot. Payment will be full compensation for the work prescribed in this section and the contract documents.

The Engineer will pay for the accepted Additional Crack Repair by Epoxy Injection 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 Crack Repair by Epoxy Injection, 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.

The Engineer will pay for the following pay items when included in the proposal schedule:

Pay Item	**Pay Unit**
Crack Repair by Epoxy Injection	Linear Foot
Additional Crack Repair by Epoxy Injection	Force Account”

END OF SECTION 694