

1 Make the following Section a part of the Standard Specifications:

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3 **"SECTION 694 – CRACK REPAIR BY EPOXY INJECTION**

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5 **694.01 Description.** This work includes the repair of cracks in concrete by  
6 pressure-injecting epoxy into cracks that intersect at least one accessible surface  
7 of the concrete or masonry member. It does not cover the repair of delaminations  
8 where the intersection of the cracked concrete with the surface of the concrete  
9 member is not accessible nor can be made accessible.

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11 **694.02 Materials.**

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13 **(A) General.** Deliver all injection adhesives to the job site in sealed  
14 containers with labels intact. Store all injection adhesives between 4 and  
15 32°C (40 and 90°F) unless otherwise specified by the manufacturer.

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

21  
22 **(C) Injection Adhesives.** Injection adhesives for cracks that can be  
23 sealed on all faces – Use an adhesive that conforms to the requirements  
24 of ASTM C 881/C 881M, Type IV, Grade 1, and any additional  
25 requirements as defined in the Project Specifications.

26  
27 If all faces of the crack cannot be reached to apply a surface seal,  
28 use an injection adhesive that conforms to the requirements of ASTM C  
29 881/C 881M, Type IV, Grades 1, 2, or 3, and has a viscosity that will allow  
30 it to achieve and maintain the penetration requirements specified in  
31 Subsection 694.03H(1) – Acceptance Criteria.

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33 **694.03 Construction.**

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35 **(A) Submittals.**

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

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

47 (3) Additional testing – Submit additional test results when  
48 required.  
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50 **(B) Quality Assurance.**  
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52 **(1) Metering Accuracy.** Use equipment or tools for continuous  
53 (metering) or batch proportioning for the two components of the  
54 injection adhesive that are able to establish and maintain a ratio of  
55 the components within the tolerance specified by the manufacturer  
56 of the injection adhesive over the full range of operating pressures  
57 and temperatures. If the manufacturer of the adhesive does not  
58 specify a tolerance for the mixture ratio, maintain a mixture ratio  
59 within  $\pm 3\%$  of the nominal mixture ratio specified by the  
60 manufacturer of the adhesive.  
61

62 **(2) Qualification Test for Metering Accuracy.**  
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64 **(a)** When a continuous metering and mixing pump is  
65 required, test the metering accuracy of equipment before the  
66 start of the Work to demonstrate that the pump is capable of  
67 maintaining the ratio within the tolerances required in  
68 Subsection 694.03(B)(1) – Metering Accuracy.  
69

70 **(1)** Conduct the test using a pump discharge  
71 pressure that ranges from the lowest to the highest  
72 discharge pressure at which the equipment is  
73 expected to be operated during the injection process.  
74

75 **(2)** The device used to measure metering  
76 accuracy shall be capable of controlling the discharge  
77 pressure of each of the components separately as  
78 they are simultaneously discharged into separate  
79 containers.  
80

81 **(3)** Conduct one test by discharging both adhesive  
82 components simultaneously into separate containers  
83 while maintaining a discharge pressure on both  
84 components equal to the lowest operating discharge  
85 pressure. Conduct a second test at the highest  
86 operating discharge pressure.  
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88 **(4)** Measure injection pressure with a gauge  
89 mounted upstream of and within 300 mm (12 in.) of  
90 the mixing chamber.  
91

(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  $\pm 3\%$ . 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.

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

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

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191           **(7) Cleanup**

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

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

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

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

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

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

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

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

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218           Submit the log to the Engineer each workday.

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221           **694.04 Measurement.** The Engineer will measure crack repair by epoxy  
222 injection per linear foot according to the dimensions shown in the contract  
223 documents or as ordered by the Engineer.

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225           **694.05 Payment.** The Engineer will pay for the accepted crack repair by  
226 epoxy injection by the linear foot. Payment will be full compensation for the work  
227 prescribed in this section and the contract documents.

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

231		
232	<b>Pay Item</b>	<b>Pay Unit</b>
233		
234	Crack Repair by Epoxy Injection	Linear Foot"
235		
236		
237	<b>END OF SECTION 694</b>	