

**CHEMCO SYSTEMS
GENERAL GUIDELINE SPECIFICATION
EPOXY ADHESIVE REPAIR OF CRACKS, DELAMINATIONS AND VOIDS IN
PORTLAND CEMENT CONCRETE**

NOTE TO SPECIFIER:

ChemCo Systems provides this General Guideline Specification to the Specifier (engineers, architects, general contractors, construction managers, owners and their representatives) to assist in the establishing the requirements for repair of cracks, delaminations and voids in Portland Cement Concrete. ChemCo Systems, Pressure Injection uses two component, epoxy adhesives (low viscosity, liquid, and non-sag paste) most (but not all) meet ASTM C881 Type IV AASTHO M235 Type IV, designed for the pressure injection of cracked or delaminated Portland Cement Concrete.

The injection of epoxy adhesives developed by ChemCo Systems, KEMKO® dual component ChemCo Systems Model B or Model C pumps. ChemCo Systems has over eleven (11) KEMKO® injection resins designed repair cracks and delaminations. When injecting with low viscosity resins cracks, delaminations, voids and annular spaces greater than 1/4" (250 mils or 6.35mm) are improved with uniform in size, washed, dried, and bagged aggregate. ChemCo epoxies contain no VOCs (volatile organic compounds) and are compliant in all States and Providences in North America.

- Meets – ASTM C881 and AASHTO M235, Type IV, Grade 1 or Grade 3, and Class A or B or C are listed below.
- Meets – ACI 548.15-20 Specification for Crack Repair by Epoxy Injection
- Meets – ICRI 210.1R-2016 Guide for Verifying Field Performance of Epoxy Injection of Concrete Cracks

PART 1 – GENERAL

1. SCOPE – The contractor or the sub-contractor shall furnish all materials, tools, equipment, appliances, transportation, labor and supervision required to repair cracks, delaminations and voids by the injection of an epoxy resin/hardener adhesives.

2. PRE-QUALIFICATION

- A. Applicator's Qualifications – Epoxy adhesive injection shall be performed by a certified applicator of ChemCo Systems, using KIP™ System (KEMKO® Injection Process) automatic metering, mixing, and dispensing application equipment.
- B. Worker's Qualifications – The contractor's or sub-contractor's workers engaged in the epoxy adhesive injection process shall have satisfactorily completed ChemCo Systems' training program. The program includes methods of restoring concrete structures utilizing KIP™ system. Curriculum includes theories on the nature/cause of cracks in concrete and methods for permanently repairing damaged concrete structures. Technical aspects of selecting correct materials, use, operations, maintenance and troubleshooting of KIP™ System.

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PART 2 – MATERIAL AND EQUIPMENT

2.1 EPOXY ADHESIVE INJECTION - Insert the Specification data for the ChemCo Systems injection product selected, from the lists below

- A. Low Viscosity Injection Epoxy Adhesive:
 - 1. KEMKO® 026 UW IR Epoxy Adhesive for Underwater Pressure Injection Grouting*
 - 2. KEMKO® 030 HiAmb™ IR High Ambient Temperature Epoxy Adhesive for Pressure Injection Grouting*
 - 3. KEMKO® 038 Regular IR Injection Resin Structural Epoxy Adhesive for Pressure Injection *
 - 4. KEMKO® 050 Slump IR Injection Resin Slump Pumping, Structural Adhesive for Pressure Injection
 - 5. KEMKO® 051 LoMod IR Injection Resin Low Modulus Epoxy Adhesive for Pressure Injection
 - 6. KEMKO® 068 LoVis IR Injection Resin Low Viscosity Structural Epoxy Adhesive for Pressure Injection*
 - 7. KEMKO® 077 Large Void IR Large Void and Wide Crack Structural Epoxy Adhesive for Pressure Injection**
 - 8. KEMKO® 165 IR High Temperature Epoxy Adhesive for Pressure Injective*
 - 9. KEMKO® 322 ULV IR Ultra-Low Viscosity, Cold Weather, Epoxy-Acrylic for Pressure Injection**
- B. Paste (non-sag) Injection Epoxy Adhesive
 - 1. KEMKO® 170 LP Paste Bonder Long Pot Life Structural Epoxy Non-Sag Paste Adhesives*
 - 2. KEMKO® 171 SP Paste Bonder Short Pot Life Structural Epoxy Non-Sag Paste Adhesives*

Note: * Meets ASTM C881 Type IV
** Meets ASTM C881 Type IV, modified

2.2 SURFACE SEAL

- A. Description – The surface seal material is used to confine the injection adhesive in the fissure during injection and cure.
- B. Properties – The surface seal material shall have adequate strength to hold injection ports (if used) firmly in place and to resist injection pressures adequately to prevent leakage during the injection process.
- C. Concrete Surface Seal Materials – Select from the list below:
 - 1. KEMKO® 019 LoTemp™ Seal Epoxy Adhesive for Crack Sealing or General Bonding
 - 2. KEMKO® 022 SuperSEAL™ Extremely Short Working time for Sealing Cracks Prior to Injection
 - 3. KEMKO® 046 QuickSeal™ Epoxy Adhesive for Crack Sealing or General Bonding
 - 4. KEMKO® 104 UW Putty – Long Potlife, Toughened Epoxy Putty for Underwater Bonding

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5. KEMKO® 136 StripSEAL™ Injection Seal – Non-Sag Polyurea Crack Sealer for Concrete and Masonry Substrates
 6. KEMKO® 170 LP Paste Bonder Long Pot Life Structural Epoxy Non-Sag Paste Adhesives
 7. KEMKO® 171 SP Paste Bonder Short Pot Life Structural Epoxy Non-Sag Paste Adhesives
Decorative Concrete Surface Seal
- D. Architectural/Decorative Concrete Surface Seal Material
1. KEMKO® 136 StripSEAL™ Injection Seal – Non-Sag Polyurea Crack Sealer for Concrete and Masonry Substrates

2.3 EQUIPMENT FOR INJECTION

- A. Pumps – Equipment used to meter, mix and inject two-component epoxies into cracks, delaminations and voids shall be portable, positive displacement ChemCo Systems pumps.
 1. Model B pump shall be interlocking to provide positive ratio control of the exact proportions of the two components at the mix-head. The Model B pump shall be electric powered and shall provide in-line metering and mixing.
 2. Model C pump shall be interlocking to provide positive ratio control of the exact proportions of the two components at the mix-head. The Model C pump shall be air powered and shall provide in-line metering and mixing.
- B. Discharge Pressure – Model B injection equipment shall have automatic pressure control capable of discharging the mixed epoxy adhesive from 0 to 200 psi. The recommended maximum discharge pressure is 160 psi.
- C. Ratio Tolerance – Model B injection equipment shall have the capability of maintaining the volume ratio for the injection of epoxy adhesive prescribed by the manufacturer of the epoxy adhesive with a tolerance of + 5% by volume at any discharge pressure up to 160 psi.
- D. Automatic Shut-Off Control – Model B epoxy adhesive pump equipped with sensors on both the Component A and Component B reservoirs that will automatically stop the machine when only one component is being pumped to the mixing head.

PART 3 – EXECUTION OF WORK

3.1 Preparation

- A. Surfaces adjacent to cracks, delaminations, voids or other areas of application shall be clean of dirt, dust, grease, oil, efflorescence or other foreign matter detrimental to the bond of the crack seal materials. **Note:** Acids and corrosives shall not be permitted for cleaning the surface prior to placing the seal materials.
- B. Delaminations – Thin delaminations that may be lifted by the pressure injection process shall be mechanically pinned with threaded dowels. The project Engineer should determine the means and methods for any delamination repair. Such as, threaded dowels staged and place at one (1) foot (0.3 m) on center. The threaded dowels shall have drilled holes with an annulus no greater than 1/4 inch (250 mils or 6.35 mm) larger than the threaded dowel. The threaded dowel shall be placed with an anchoring profile at least one (1) inch (25.4 mm) in the concrete below the delamination's

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void. The threaded dowel shall be stainless steel 304, thread size M8 or larger, Grade 304, and fully threaded.

- C. Crack Entry Ports – Entry ports provide access to the cracks, delaminations and voids. Ports shall be provided along the crack face at intervals of not less than the thickness of the concrete member.
- D. Surface seal material shall be applied to the face of the crack at 1/2 inch (500 mils or 12.7 mm) minimum to each side of the crack between entry ports. For through cracks, surface seal; shall be applied to both crack faces. If access is only available from one side, use the appropriate injection adhesive.
- E. Time Between Sealing and Injection – Allow enough time based on surface temperature for the surface seal material to gain adequate strength before pumping injection epoxy adhesives. ChemCo Systems has rapid setting seal materials to long working time sealing materials, select the appropriate seal for the project.

3.2 Epoxy Injection

- A. Injection of epoxy adhesive shall begin at lower entry port and continue until there is an appearance at the next entry port adjacent to the entry port being pumped.
- B. When the epoxy adhesive travels, an indicated by appearance at the next adjacent entry port, injection shall be transferred to the next adjacent entry port where access is available to both sides of the cracks. If access is only available from one side, use the appropriate injection adhesive. Contact ChemCo Systems for recommendations.
- C. Continuously inject epoxy adhesive until cracks, delaminations and voids are completely filled.
- D. If entry port to entry port travel of the epoxy adhesive is not indicated, the work shall immediately be stopped, and the Engineer notified.
- E. Cracks, delaminations and voids can only be penetrated based on the epoxy adhesive viscosity limitations; viscosity is temperature dependent.

3.3 Finishing

- A. After the cracks, delaminations and voids are completely filled and the injection epoxy adhesive shall be cured:
 - 1. For economic reasons, the surface seal can be left in place.
 - 2. Surface seal materials, injection ports, and injection adhesives (runs or spills) can be removed from concrete surfaces.
 - 3. If elected, by the project Engineer, the face of the concrete cracks, delaminations and voids shall be finished flush to the adjacent concrete showing no indentations or protrusion caused by the placement of entry ports.

3.4 Field Quality Control Prior to Injection Model B Pump

- A. Pressure Test Model B Pump
 - 1. The mix head of the injection equipment shall be disconnected and the two-adhesive delivery lines shall be attached to the pressure check device. The pressure check device shall consist of two independent valved nozzles capable of controlling flow rate and pressure by opening

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or closing the valve. The pressure gauge shall be capable of sensing the pressure build-up behind each valve. The valves on the pressure gauge on each line reads 160 psi. The pumps shall be turned off and the pressure gauge shall not drop below 150 psi within 5 minutes.

2. Frequency of Model B Pressure Tests – The pressure test shall be run for each Model B injection pump at the beginning of each day the unit is used.
3. If the Model B pump fails the test; the equipment must be repaired and retested until it meets the test.
4. Records of Pressure QC – A record of each Pressure Test shall be kept in the daily job log, recording time and results of each test. The injection contractor or sub-contractor is responsible for accuracy of the records and are available to the project Engineer upon request.

B. Ratio Test Model B Pump

1. The mix head of the injection equipment shall be disconnected and the two adhesive components shall be pumped simultaneously through the ratio check volume device. The ratio check device shall consist of two independent valved nozzles capable of controlling back pressure by opening and closing the valve. There shall be a pressure gauge capable of sensing the back pressure behind each valve.
2. The discharge pressure shall be adjusted to 160 psi or at the pressure specified. Both adhesive components shall be simultaneously discharged into separate volume calibrated containers. The amount of epoxy adhesive discharge into the calibrated containers at the same time shall be compared to determine that the volume/discharge conforms to 2:1 ratio.
3. If the Model B pump fails the Ratio Test; the equipment must be repaired and retested until it meets the test.
4. Records of Ratio QC – A record of each Ratio Test shall be kept in the daily job log, recording time and results of each pressure test. The injection contractor or sub-contractor is responsible for accuracy of the records and are available to the project Engineer upon request.

C. Ratio Test Model C Pump

1. Mix head of the injection equipment shall be disconnected and the two adhesive components shall be pumped simultaneously to volume devices.
2. Both adhesive components shall be simultaneously discharged into separate volume calibrated containers. The amount of epoxy adhesive discharge into the calibrated containers at the same time shall be compared to determine that the volume/discharge conforms to 1:1 ratio.
3. If the Model C pump fails the Ratio Test; equipment must be repaired and retested until it meets the test.
4. Records of Ratio QC – A record of each Ratio Test shall be kept in the daily job log, recording time and results of each volume record test. The injection contractor or sub-contractor is responsible for accuracy of the records and are available to project Engineer upon request.

D. Mixing Test Model C Pump

1. The mix head and static mix wand of the Model C Pump shall be connected and the pump shall discharge both epoxy adhesive components demonstrating that the white A component and the black B component are thoroughly mixed.

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2. Thoroughly mixed epoxy adhesive A Component and B Component shall be an uniform gray mixed material.
 3. Do not connect to the injection port until the mixed material is gray without any streaks of white or black.
 4. If the Model C pump fails the ratio test; the equipment must be repaired and retested until it meets the test.
 5. Records of Ratio QC – A record of each Mix Ratio Test shall be kept in the daily job log, recording time and results of each volume record test. The injection contractor or subcontractor is responsible for accuracy of the records and are available to project Engineer upon request.
- E. Field Quality Control During the Injection Process
1. Port-to-Port Continuity – Port-to-Port Continuity is critical. The project Engineer should require that contractor or subcontractor records the port-to-port continuity or lack thereof. ChemCo Systems recommends that:
 - a. Port-to-port continuity be marked with white caulk using the infinity sign ∞
 - b. Non-continuity port-to-port should be marked with nil-set sign \emptyset
 2. The continuity and non-continuity signs should be large enough that the project Engineer can easily read them and photograph them from afar.
 3. Contractor/subcontractor and the project Engineer should maintain a Field Quality Control manual with documentation and pictures of continuity or lack thereof.
 4. Destructive cores can be taken to verify the presents of epoxy-injection-resin. Keep in mind that cores can seriously damage the physical and mechanical properties of the concrete.
 5. It is recommended that an experienced third-party testing lab perform or supervise all coring.
- F. Field Quality Control Post Injection Concrete Core Tests
1. All cores are to be taken by an experienced third-parting testing firm at locations determined by the project Engineer. Note: It is imperative that no post tension tendons be cut. Where possible no rebar should be cut.
 2. If project Engineer requires validation of 90% epoxy adhesive fill of cracks, delaminations and voids one or more cores can be taken.
 3. Diameter, depth, and quantity of core or cores to be specified by the project Engineer.
 4. Preparation, handling, storage, and transportation of epoxy adhesive injected cores to be sent to material testing laboratory by experienced third-party testing firm at the direction of the project Engineer.
 5. The core or cores shall be visually observed for percentage of penetration of the epoxy adhesive. Visual observation can be enhanced by observing the penetration under a “black light” which will highlight the epoxy adhesive. Organic epoxy adhesive will glow blue-white under a black light and it will highlight very tight crack filling by epoxy adhesives, not easily seen by the naked eye.
 6. Coring and testing to determine epoxy adhesive strength and degree of penetration are at the expense of the owner or their representatives.

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7. Test Requirements – Compressive bond strength of the concrete core's should be 6,500 psi or failure of the concrete.
8. Evaluation and Acceptance of Concrete Core Testing – If the initial core passes the tests as specified above, the epoxy adhesive injected specimen shall be accepted.
9. If initial concrete core's fails either by lack of penetration or bond strength, the injection work may be rejected. Most cracks, delaminations and voids cannot be re-injected. Contact Chemco Systems if this occurs.

END SPECIFICATION

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