

SECTION 03 64 24
POLYURETHANE INJECTION GROUTING

PART 1 GENERAL

1.01 REFERENCES

- A. The following is a list of standards that may be referenced in this section:
1. ASTM International (ASTM):
 - a. D638, Standard Test Method for Tensile Properties of Plastics.
 - b. D1622, Standard Test Method for Apparent Density of Rigid Cellular Plastics.
 - c. D1623, Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
 - d. D3574, Standard Test Method for Flexible Cellular Material Slab, Bonded, and Molded Urethane Foams.
 2. National Sanitation Foundation (NSF):
 - a. Standard 60, Standard for Drinking Water Treatment and Chemicals—Health Effects.
 - b. Standard 61, Standard for Drinking Water System Components—Health Effects.

1.02 DEFINITIONS

- A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.
- B. Injection: Method of bonding together; method of addressing or eliminating leakage through cracks or joints by installing polymer under pressure to fill the void in crack or joint.
- C. Joint: Planned and formed discontinuity in concrete structure at junction of adjacent and sequential concrete placements, and may contain embedded waterstops.
- D. Leak or Leakage: Crack or joint exhibiting moisture, sign of efflorescence, intermittent wet to touch, or continuous flow of liquid.
- E. Narrow Cracks: Width equal to or less than 0.015 inch.
- F. Wide Crack: Wider than 0.015 inch.

1.03 SUBMITTALS

A. Action Submittals:

1. Physical and chemical properties for polyurethane injection resin.
2. Technical data for metering, mixing, and injection equipment.
 - a. Marked up drawings showing locations of proposed polyurethane injection work, including the following:
 - 1) Exact locations for injection.
 - 2) Depth of penetration or crack.
 - 3) Width of crack measured every 4 feet minimum.
 - 4) Length of penetration or crack.
 - b. Proposed materials.
 - c. Injection procedure, including the following:
 - 1) Preparation of penetration for polyurethane.
 - 2) Fittings for installation for injection.
 - 3) Temperature of installation.
 - 4) Measurement and monitoring of injection pressure.
 - 5) Surface cleaning and repair.
3. Sample bottle.

B. Informational Submittals:

1. Manufacturer's recommended surface preparation procedures and application instructions for polyurethane resin injection.
2. Manufacturer's Certificate of Compliance in accordance with Section 01 67 00, Product Requirements. Certified test results for each batch of polyurethane.
3. Statements of Qualification for Polyurethane Resin Injection:
 - a. Manufacturer's Site representative.
 - b. Injection applicator.
 - c. Injection pump operating technician.
4. Health and Safety Plans for confine space entry.
5. Sample of polyurethane resin mix ratio and injection pressure test records for concrete crack and joint injection work.
6. Installation instructions for repairing core holes with repair mortar.
7. Polyurethane resins injection pressure test records for concrete crack and joint injection work.

1.04 QUALITY ASSURANCE

A. Qualifications for Injection Staff:

1. Manufacturer's Site Representative:
 - a. Capable of instructing successful methods of polyurethane injection process for concrete structures.

- b. Understands and is capable of explaining technical aspects of correct material selection and use.
 - c. Experienced in the operation, maintenance, and troubleshooting of application equipment.
- 2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:
 - a. Licensed or certified by polyurethane resin manufacturer.
 - b. Minimum 3 years' experience in successful polyurethane injection.

1.05 PERFORMANCE REQUIREMENTS

- A. Injected polyurethane resin shall fill cracks and joints, and in no case shall depth of penetration of injection material be less than 90 percent of:
 - 1. Full thickness of the concrete section for cracks.
 - 2. Depth between the waterstop and the outside face of the structure for joints.
- B. In cured state, injected polyurethane resin forms a dense rubber-like closed cell flexible foam compression gasket-type seal material.
- C. Notwithstanding the foregoing, injected cracks or joints which exhibit leakage are considered deficient work irrespective of the depth of penetration observed in quality control core drilled samples. Reinject deficient work as required to meet the performance requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping:
 - 1. Package adhesive material in new sealed containers and label with following information:
 - a. Manufacturer's name.
 - b. Product name and lot number.
 - c. ANSI Hazard Classification (formerly SPI Classification).
 - d. ANSI recommended precautions for handling.
 - e. Mix ratio by volume for accelerator.
- B. Storage and Protection: Store polyurethane resin material containers in accordance with manufacturer's printed instructions or in the absence of such information at ambient temperatures below 110 degrees F and above 68 degrees F.

PART 2 PRODUCTS

2.01 POLYURETHANE RESIN

- A. Physical Characteristics: Single-component, water-activated, hydrophilic polyurethane injection resin.
- B. Functional Characteristics: None.
- C. Performance Characteristics:
 - 1. Accelerator: Compatible with polyurethane resin from same manufacturer.
 - 2. Elongation: Minimum 350 percent, in accordance with ASTM D3574 or ASTM D638 test method.
 - 3. Tensile Strength: Minimum 150 psi, in accordance with ASTM D3574 or ASTM D638 test method.

2.02 SURFACE SEAL

- A. Provide seal with sufficient strength and adhesion for holding injection fittings firmly in place, and to resist pressures preventing leakage during injection.
- B. Capable of removal after injection resin has cured.

2.03 WATER

- A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

2.04 SAMPLE BOTTLE

- A. 5 inches natural wide mouth HDPE bottle or 4 ounces clear PVC cylinder bottle, supplied with caps.

2.05 SOURCE QUALITY CONTROL

- A. Test Requirements: Perform tests for each batch of polyurethane resins.

PART 3 EXECUTION

3.01 GENERAL

- A. Use of polyurethane injection shall be limited to locations as determined by Contracting Officer.

- B. Unless permitted otherwise, polyurethane inject cracks and joints listed below:
 - 1. Cracks and joints that leak.
 - 2. Cracks and joints exhibit dampness, efflorescence, or other evidence of leakage.
- C. Do not proceed with injection work until action submittals have been reviewed and approved by the Contracting Officer.
- D. Perform injection work after performing surface preparation.
- E. Width of the cracks shown may vary along the length and through the thickness of the concrete section.
- F. Remove all excess unused polyurethane resins materials inside the structure prior to the end of the work.

3.02 EQUIPMENT

- A. Portable, positive displacement type pumps with in-line metering to meter mixed components, and inject mixture into crack or joint.
- B. Pumps:
 - 1. Positive displacement type pump.
 - 2. Equip the polyurethane injection equipment with pail heater(s) suitable for plastic pails capable of maintaining the polyurethane resin and accelerator mixture between 50 degrees F and 160 degrees F.
 - 3. A thermometer with each pump for monitoring the temperature of the polyurethane resin.
- C. Discharge Pressure: Automatic pressure controls capable of discharging mixed polyurethane resin at pressures in accordance with polyurethane resin manufacturer's printed instructions, and able to maintain such pressure.
- D. Proportioning Ratio Tolerance: Maintain polyurethane manufacturer's prescribed mix ratio within a tolerance in accordance with polyurethane resin manufacturer's printed instructions.
- E. Pressure gauge capable of sensing pressure behind valve.

3.03 PREPARATION

- A. Free cracks and joints from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.
- B. Clean cracks and joints in accordance with polyurethane resins manufacturer's printed instructions.

- C. Clean surfaces adjacent to cracks and joints from dirt, dust, grease, oil, efflorescence, encrustation, and other foreign matter detrimental to bond of surface seal system and to expose the full extent of cracks and joints in accordance with manufacturer's printed instructions.
- D. Do not use acids and corrosives for cleaning, other than those specified herein, unless neutralized prior to injecting polyurethane resin.
- E. During installation and curing of materials, if the ambient temperature is expected to drop below the manufacturer's recommended minimum temperature, provide enclosures and heat as required.
- F. Provide work platforms as required.

3.04 APPLICATION

A. Injection Ports:

1. Drill holes shall be installed along cracks and joints designated for injection as required to meet the performance requirements for injection.
2. The requirements for installing drill holes for injection provided below represent acceptable minimum standards of practice.
3. Drill holes for injection at an angle between 45 degrees and 60 degrees from the surface of the concrete and perpendicular to the cracks or joints alignment, to intersect the cracks at the midpoint of the concrete section, and intersect the joints at the midpoint between the waterstop and interior concrete surface, except as noted otherwise.
4. Locate drill holes on alternate sides of the crack or joint where possible, unless orientation of the crack or joint is known or has been verified by nondestructive testing techniques or core drilling.
5. The spacing of drill holes not to exceed the concrete thickness or 12 inches (maximum), except as noted otherwise.
6. Adjust location and angle of drill holes to suit orientation of crack or joint and at required angle, such as using a template, during the Work especially at the commencement of drilling holes for injection and at the beginning of each subsequent shift.
7. Take measures to prevent drilling holes for injection too shallow, or too deep, and/or damaging the existing waterstop in the joints. Shallow hole injections lead to concrete spalls. Repair spalls at Contractor's expense.
8. Remove dust and debris in drill holes and on interior surface of the structure resulting from drilling operation, by flushing with water prior to installing injection packers or ports.
9. Install injection packers or ports in drill holes in accordance with manufacturer's printed instructions with zerk coupling, or other one-way ball or check valve, to permit testing for watertightness and acid flushing of cracks and joints.

- B. Apply surface seal along the length of the cracks and joints designated for injection on the top side and underside of slabs, or both Application of Surface Seal Along Cracks and Joints:
1. sides of walls, where possible in order to contain, confine, and prevent escape of the injected polyurethane resin, in accordance with manufacturer's printed instructions.
 2. Cure the surface seal in accordance with the material's manufacturer's printed instructions.
- C. Mixing Polyurethane Injection Resin:
1. Add accelerator to polyurethane injection resin at the required dosage to produce cured polyurethane material meeting performance requirements, and mix thoroughly in accordance with manufacturer's printed instructions until a homogeneous mixture is obtained outside of the structure.
 2. Heat polyurethane injection resin materials prior to and during mixing and injection as required and in accordance with manufacturer's printed instructions to a temperature between 85 degrees F and 130 degrees F. Injection of polyurethane resin when it is less than 85 degrees F or more than 130 degrees F is prohibited.
- D. Polyurethane Injection of Cracks and Joints:
1. Inject polyurethane resins, mixed with accelerator or in a neat form, into cracks and joints in a sequential manner, and reinjection as required, to meet the performance requirements.
 2. Start injection into each crack or joint at lowest elevation entry port for vertical or diagonal cracks and joints and at one end for horizontal cracks and joints in vertical structure. Continue injection at first port until pure uncontaminated resin begins to flow out of next port. Plug first port and start injection at second port until polyurethane resin flows from next port. Inject crack or joint in a sequential manner until the full length of the crack or joint has been injected. At no time inject more than 6 feet length of vertical crack or joint before verifying that the first 12 inches of injected crack or joint is set and cured.
 3. Prior to commencing the injection work along a crack or joint in horizontal structure when packers with zerk couplings are used, remove the zerk couplings from the injection packers or ports except for the two packers located where the injection work will commence. Commence injection work in the first two packers. Once clean resin is vented from the third injection packer, cease injection at the first packer, and install the zerk coupling and commence injection at the third packer. Repeat the process for the fourth and subsequent packers until the full length of the crack or joint has been injected.

E. Finishing:

1. Cure polyurethane resins after crack or joints has been completely filled without draining or runback of polyurethane resin material from crack or joints.
2. Remove surface seal and injection packers or ports from along the crack or joints.
3. Finish surface flush and to match surrounding concrete.
4. Indentations or protrusions caused by placement of entry ports drill holes, or damage from removal of surface seal, is not acceptable.
5. Grind off protrusions, and patch indentations and holes from packers and ports with a suitable patch material to the satisfaction of the Contracting Officer.
6. Remove surplus surface seal material on splatters and injection material runs and spills from concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect polyurethane component delivery line to pressure check device.
2. Pressure Check Device:
 - a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
 - b. Pressure gauge capable of sensing pressure buildup behind each valve.
3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within 3 minutes.
5. Run pressure Test for Each Injection Equipment Unit:
 - a. Beginning and end of each injection work day.
 - b. When injection work has stopped for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

B. Bottled Samples:

1. During the injection operation, provide at least one sample of the mixed polyurethane injection resins per shift per injection pump in a sample bottle.
2. Half fill each sample bottle, containing a small amount of water (5 percent by volume) with polyurethane injection resin material from the pump discharge hose. Swirl or lightly shake sample to thoroughly

mix resin with the water. When foaming rises near the top of the bottle, install the cap to contain the expanding resin material.

3. Label each bottled sample with Contractor's name, date and time sample was taken, and location in structure where sample was taken. Maintain a log of bottle samples.
4. Place filled sample bottle upright in a box or pail and allow sample to cure.
5. After sample cured, cut bottled sample open and visually inspect contents to verify that polyurethane injection resins material has completely reacted and cured.
6. Evaluation and Assessment of Test:
 - a. If a bottled sample(s) indicates a problem with the polyurethane injection resins, such as polyurethane resin not cured; take verifying core sample immediately from the cracks or joints, where the material was used.
 - b. If the above-referenced bottle sample(s) and core sample(s) indicate a problem with the polyurethane injection resins, have a Technical Representative of the polyurethane injection resins manufacturer come to site to review bottled sample(s) and core drilled sample(s) with Contracting Officer and provide technical advice on corrective measures.
 - c. Carry out further investigation work or corrective measures recommended by the Technical Representative of the polyurethane injection resins manufacturer.

C. Visual Inspection:

1. Confirm injection of polyurethane has stopped the leaking material.
2. Confirm installation of material is in accordance with manufacturers' requirements.
3. Confirm installation of material is not damaging concrete.

END OF SECTION

