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*Note: The paragraphs below are meant to be incorporated into Parts 2 and 3 of a standard CSI 3 Part Format specification, the General Structural Notes, or directly onto the plans. They must be carefully reviewed by a qualified design professional and edited to meet the requirements of the project and governing building codes. Coordinate with other specification sections and drawings. In no case shall these Guide Specifications be considered to be Contract Documents or serve as installation instructions for the product being discussed. In any cases of discrepancy the manufacturer's most recently published data sheet shall take precedence.*

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SECTION 03 64 00 EPOXY INJECTION OF CRACKS IN CONCRETE

PART 1: GENERAL

1.01 SUMMARY

 A. Furnish all labor, materials, tools, and equipment to perform crack repairs of structural

concrete with an epoxy adhesive using automated pressure injection.

*Insert related sections below.*

 B. Related Sections include following:

 1. **<<Insert Related Sections>>**

1.02 REFERENCES

A. Comply with provisions of following codes, specifications and standards except where more stringent requirements are shown on Drawings or specified herein:

1. ACI SPEC 548.15-20 - Specification for Crack Repair by Epoxy Injection by American Concrete Institute.

1.03 SUBMITTALS

 A. Submit following in accordance with Division 1 General Requirements:

1. Product standards, physical and chemical characteristics, storage requirements, technical specifications, limitations, maintenance instructions, and general recommendations regarding each material indicated.

 a. Epoxy Injection Resin

b. Capping Adhesive

c. Equipment for Metering, Mixing, and Injecting

d. Injection Ports

B. Qualifications: Submit documentation demonstrating conformance with qualification requirements for Contractor providing epoxy injection and supervisory personnel for Contractor as described in Quality Assurance section

C. Quality Control Test Results: Submit copies of all quality control test results and field verification reports.

1.04 QUALITY ASSURANCE

A. Manufacturing Qualifications: Manufacturer of specified product must be ISO 9001/9002 certified and have in existence a recognized ongoing quality assurance program.

B. Epoxy Injection Contractor Qualifications:

*Note to Specifier: Insert required number of completed projects below.*

1. Epoxy injection contractor must have completed a minimum of **[3][5]** epoxy injection repairs within last 3 years similar in type and scope to Work of this Contract.

2. Assign experienced mechanics from previous applications including lead mechanic. These personnel are to be on site at all times while work is being performed.

*Retain paragraph below if project scope justifies a mockup. Mock-ups can be used to verify several items including the following:*

*1. The epoxy injection procedure for the specific project application.*

*2. The Contractor’s competency to complete the work.*

*3. In-situ field testing for strength, material travel and crack filling.*

*4. Final aesthetics for coordination with potential architectural finishes.*

C. Mock-ups: Provide mock-ups to demonstrate that equipment, personnel, and installation methods are capable of producing crack repair results satisfactory to Design Professional. Construct mockups using same personnel, equipment and materials that will be used for final work. Follow installation method specified in design documents or in accordance with manufacturer’s recommendations. Conduct mock-ups in areas designated by Design Professional. Notify Design Professional in writing at least 48 hours in advance of mockup placement to allow for inspection and acceptance of Work.

1. Mock-ups to consist of two cracks, each not less than 10 ft (3 m) long.

2. Obtain one verification core from each mock-up location.

3. Mock-up cracks will be accepted if they meet test requirements outlined herein.

4. Accepted mock-ups are permitted to become part of completed Work if undisturbed at time of Substantial Completion.

5. Representative from epoxy resin manufacturer must be present to witness

epoxy injection process during Mock-Up.

 D. Job Site Testing:

1. Pressure Check of Epoxy Injection Equipment: At beginning of work on each day, perform pressure check test on injection equipment in accordance with manufacturer’s written instructions.

2. Metering Accuracy of Epoxy Injection Equipment: Test metering accuracy of equipment prior to start of work first time any two component continuous metering and mixing equipment is used in Work and any time each piece of equipment has experienced 4 hour or longer shutdown period.

a. Disconnect mixing head of injection equipment. Pump two adhesive components simultaneously through ratio check device. Adjust discharge pressure to 200 ± 10 psi (1.4 ± 0.07 MPa) for both adhesive components and discharge components simultaneously into separate calibrated containers for 60 ± 5 seconds.

1) Ratio check device must consist of two independent valved nozzles capable of controlling flow rate and back pressure by opening or closing valve to restrict material flow. Device must be equipped with pressure gauge capable of measuring back pressure behind each valve.

b. Compare amounts simultaneously discharged into calibrated containers to determine mix ratio. If ratio of two components is not with +/- 3 percent of nominal mixing ratio stop injection work until equipment is brought into compliance.

c. Maintain record of all such tests including date, time, temperature and results of test.

3. Core Testing:

a. Obtain verification core samples at specified crack repair locations in accordance with ASTM C42.

1) Visual Observation: Two cores for initial 50 ft (15 m) of crack repair; and one core for each additional 100 ft (30 m) of crack repair.

2) Bond Strength (ASTM C496): One core for initial 50 ft (15 m) of crack repair; and one core for each additional 200 ft (60 m) of crack repair.

b. Locate existing reinforcement, embedments, and utilities in designated core locations. Ensure location specified does not conflict with existing reinforcement, embedments, and/or utilities.

c. Position cores such that repaired crack bisects center of core.

d. Core diameter to be minimum of three times that of maximum size aggregate in concrete. Core length to be full depth of repaired crack, unless shorter length is permitted by Design Professional.

e. Visually examine verification cores to determine depth of penetration of epoxy adhesive.

f. Test verification cores in accordance with ASTM C496 to confirm that bond strength of epoxy adhesive is acceptable. Test cores with repaired crack oriented vertically, such that splitting tensile stresses are applied perpendicular to plane of crack. Bond strength of epoxy adhesive will be acceptable if splitting tensile test demonstrates that 90 percent of repaired crack plane remains intact.

g. Fill core holes with specified core hole repair mortar. Mix and apply per manufacturer’s instructions.

 E. Acceptance Criteria:

1. Core testing must demonstrate that at least 90 percent of crack in each core is filled with Epoxy Injection Resin and splitting tensile strength of core taken from that location is 90 percent of splitting tensile strength of core taken from uncracked area within 12 inches of repaired crack; or splitting tensile strength of core indicates that no more than 10 percent of bonded area of crack in each core exhibits combined areas of separation of adhesive from concrete or cohesive failure within Epoxy Injection Resin.

1.05 DELIVERY AND STORAGE

A. Deliver crack injection materials to job site in original unopened containers with labels clearly attached.

B. Store crack injection materials indoors, protected from moisture, at temperatures between 50°F and 90°F.

C. Do not use materials that have exceeded their expiration date.

D. Store all materials off ground, under cover, and in dry location. Protect from rain, water, freezing, and excessive heat, foreign matter and other damaging conditions until ready for use. Comply with manufacturer’s material storage guidelines. If materials have frozen, obtain manufacturer’s written approval prior to use. Do not stir liquids or mix materials until they are completely thawed. Do not force-thaw materials. Do not use damaged containers.

E. Comply with material manufacturer’s ordering instructions and lead-time requirements to avoid construction delays.

1.06 JOB SITE CONDITIONS

A. Surface and ambient temperature during applications must be between 50°F and 90°F

B. Material temperatures must be at least 50°F and rising at time of application.

C. Do not inject Epoxy Injection Resin into cracks if water is leaking from crack or standing water is present in crack.

PART 2 PRODUCT

2.01 EQUIPMENT FOR METERING MIXING AND INJECTING EPOXY

A. Epoxy Injection Equipment: Epoxy injection unit must be portable and equipped with positive displacement type pumps with interlock to provide positive ration control of epoxy injection resin components. Pumps must be air or electric powered and must provide in line mixing and metering system and be equipped with drain back plugs.

1. Equipment used to inject epoxy must be capable of following:

a. Automatic proportioning of materials within mix ratio tolerances of +/- 3 percent over full range of operating pressures and temperatures.

b. Delivery of components, resin and hardeners, from separate reservoirs to mixing type discharge head

c. Complete and uniform mixing of components at discharge head.

d. Operating pressure of 50 psi up to 200 psi.

e. Demonstrate that injection equipment does not have more than 5 psi drop in pressure in either of two component lines after operating with no flow for 3 minutes with at least 80 percent or more of operating pressure.

2.02 EPOXY INJECTION MATERIALS

A. Choose from products below as required to complete work as specified.

*Note that Euclid Dural Fast Set LV is not included in the body of this specification. It is typically used to inject members that are narrower than 6 inches. Product descriptive specification language for this product can be found at the following link* [***DURAL FAST SET LV****.*](https://www.euclidchemical.com/products/construction-products/bonding-agents-adhesives/epoxy/dural-fast-set-lv/)

B. **Low Viscosity, Epoxy Injection Resin:** Two component, low viscosity, high modulus, pre-proportioned, moisture insensitive, VOC compliant, 100 percent solids epoxy adhesive. Product must conform to ASTM C881 Type IV, Grade 1, Class C. Material must have following properties @ 73 deg F (22 C):

1. Compressive Yield in accordance with ASTM D695 Minimum 15,500 psi (106.9 MPa)

2. Bond Strength in accordance with ASTM C882 Minimum 1,750 psi (12.1 MPa) @ 14 days

3. Mixed Viscosity of 450 cp

4. Gel Time 34 minutes in accordance with ASTM C881

5. Basis of Design Product:

a. **Euclid Chemical Company (The);** **Dural 452 LV Epoxy** **www.euclidchemical.com**

C. **Ultra-Low Viscosity, Epoxy Injection Resin:** Two component, low viscosity, high modulus, pre-proportioned, moisture insensitive, VOC compliant, 100 percent solids epoxy adhesive. Product must conform to ASTM C 881 Type IV, Grade 1,Class C. Material must have following properties @ 73 deg F (22 C):

1. Compressive Yield in accordance with ASTM D695 Minimum 11,000 psi (75.8 MPa) @ 7 days

2. Slant Shear Bond Strength in accordance with ASTM C882 Minimum 2,100 psi (15.5 MPa) @ 14 days

3. Mixed Viscosity of 80 to 120 cp

4. Gel Time 70 to 90 minutes in accordance with ASTM C881

5. Basis of Design Product:

**a. Euclid Chemical Company (The);** **Dural 335** **www.euclidchemical.com**

D. **Gel Consistency Epoxy Injection Resin**: Two-component, gel consistency, high modulus, pre-proportioned, moisture insensitive, VOC compliant, 100 percent solids epoxy adhesive. Product must conform to ASTM C 881 Type IV, Grade 3,Class C. Material must have following properties @ 73 deg F (22 C):

1. Compressive Yield in accordance with ASTM D695 Minimum 10,000 psi (68.9 MPa) @ 7 days

2. Slant Shear Bond Strength per ASTM C882 Minimum 2,500 psi (17.2 MPa) @ 14 days

3. Consistency per ASTM C881 of 1/16 inch (1.6 mm)

4. Gel Time 33 minutes in accordance with ASTM C881

5. Basis of Design Product:

**a. Euclid Chemical Company (The);** **Dural Injection Gel** **www.euclidchemical.com**

E. **Epoxy Injection Surface Seal/Capping Adhesive:** Two component, high modulus, pre-proportioned, moisture insensitive, VOC compliant, 100 percent solids epoxy adhesive. Products must conform to ASTM C 881 Types I, II, IV, and V, Grade 3, Class C. Material must have following properties @ 73 deg F (22 C):

1. Compressive Yield in accordance with ASTM D695: Minimum 10,000 psi

2. Bond Strength in accordance with ASTM C882 Minimum 2,500 psi @ 14 days

3. Basis of Design Product:

1. **Euclid Chemical Company (The); Dural Fast Set Gel or Dural 452 Gel Epoxy www.euclidchemical.com**

F. Core Hole Repair Material: Single-component, quick-setting, low-shrinkage cement-based repair mortar with fiber reinforcement and integral corrosion inhibitor, formulated for trowel-applied vertical and overhead repairs of concrete structures. Material must have following properties:

1. Compressive Strength per ASTM C109

3 hours 2,000 psi

1 day 3,000 psi

7 days 4,500 psi

28 days 6,000 psi

2. Shrinkage per ASTM C157

 28 days -0.02 percent

3. Crack Resistance per ASTM C1581

 Net Time Until Cracking >45 days

 Stress Rate: 6.7 psi per day

 Potential for Cracking: Low

4. Basis-of-Design Product:

**a. Euclid Chemical Company (The);** **EucoRepair V100** **www.euclidchemical.com**

PART 3 EXECUTION

3.01 SURFACE PREPARATION

A. Clean areas to receive Capping Adhesive of laitance, loose or unsound materials, oil, dirt, and other substances that would interfere with bond. Mechanically abrade surface to receive Capping Adhesive to achieve Concrete Surface Profile (CSP) of 2 to 5 in accordance with ICRI Guideline 310.2.

B. Remove foreign materials such as dirt, dust, oil, grease or other chemicals from crack prior to injection.

C. Place one-way polyethylene valves or injection ports at spacing no farther apart than thickness of member being injected. Spacing of port devices to be as required to achieve travel of Epoxy Injection Resin between ports and fill cracks completely. Seal injection ports in place with capping adhesive.

D. Seal cracks at all exposed surfaces with a ribbon of Capping Adhesive at least 1 inch (25 mm) wider than crack.

E. Prior to commencement of epoxy injection cap all ports and inject air at high pressure through every tenth port minimum to test for leaks. Mark any leaks that can be felt with bare hand and repair with Capping Adhesive.

3.02 EPOXY INJECTION UNDER PRESSURE

A. Protect all surroundings from epoxy adhesive products.

B. Begin injection of epoxy and continue until there is appearance of epoxy at injection port directly adjacent to injection port being pumped, thus indicating epoxy travel.

1. For cracks in vertically inclined surfaces begin injection at lowest elevation.
2. For cracks in horizontal surfaces begin injection at widest crack opening.

C. When positive epoxy travel is indicated, install an additional injection line onto adjacent port and continue injection until epoxy travel is indicated in next port. At that time, discontinue injection on first port injected, and seal that port.

D. Move first preceding line to next adjacent port showing epoxy travel and continue injection.

E. Perform this “alternating injection” continuously from port to port until crack has been filled with epoxy along entire length.

F. When cracks are completely filled, allow epoxy to cure for sufficient time to allow removal of cap seal material without any draining or runback of epoxy adhesive from cracks.

G. If port-to-port travel is not achieved, immediately notify Design Professional.

H. If, in order to achieve required penetration of areas being injected, epoxy injection installation procedures specified herein require modification, submit such modifications to Design Professional for acceptance before recommencing work.

3.04 CLEANING

1. Remove ports and capping adhesive and grind flush with surrounding concrete.
2. Remove any epoxy resin or run down from surface of wall.

END OF SECTION