



A GIBRALTAR INDUSTRIES COMPANY 

EPOXY INJECTION

For Concrete, Masonry and Wood



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Part 1 General Information

Section 1.1 WORK INCLUDED

A. This specification covers the procedure, materials, testing, and workmanship necessary to structurally repair cracks and damaged surface areas in existing concrete, masonry, and timbers using the USP Structural Connectors epoxy injection system. The repair procedure will bond concrete back to its original pre-cracked monolithic strength. Cracks shall be repaired by the injection of epoxy resin adhesive. Surface areas shall also be prepared and repaired using an epoxy resin as specified. Cracks and surface areas requiring repair will be field located and identified by the engineer prior to the start of work in that area. Some cracks, regardless of size and condition, may not be designated by the engineer for repair.

Part 2 Inspection of Project

Section 2.1 SUITABILITY

A. It is important to determine the cause of the original cracking in the concrete. Failure to identify the problem before repairs are made and/or selection of the wrong product(s) for repair may result in re-cracking of the repaired concrete as the material adjusts to remove internal stresses. Inspect the crack for openness, contamination, and size. Proceed with the preparation if the crack is stable and it is determined that crack injection is a viable solution by the engineer and field personnel.

Part 3 Products, Equipment, and Material Selection

Section 3.1 GENERAL SPECIFICATION

A. Epoxy products, equipment, and accessories shall be as manufactured by USP Structural Connectors or equivalent, meeting the requirements specified hereinafter.

Section 3.2 DISPENSING AND MIXING EQUIPMENT

A. The adhesive components shall be contained in equal volume side by side plastic cartridges. Refer to Section 3.3 for properties of material components.

B. The epoxy shall be dispensed with either a hand or pneumatic powered tool capable of simultaneously dispensing the two components utilizing a common driving mechanism, which cannot be altered to change the component ratio. The pneumatic tool shall be equipped with a pressure relief valve and a regulator. The components shall be mixed automatically as they are dispensed through a spiral motionless mixer to achieve consistency of color and ratio.

Item No.	Injection Tools	Item No.	Injection Accessories
PDT-22	Pneumatic Dispensing Tool	CNOZ12	Step-down Mixer Nozzle
HDT-22	Hand Dispensing Tool	304	Mixer Retaining Nut
		ACRNOZ	1/4" Injection Resin Nozzle
		804	Flush-mounted Injection Ports
		805	Corner-mounted Injection Ports

Section 3.3 ADHESIVE FOR INJECTION

A. The epoxy adhesive used for injection shall comply with the following material specifications. In addition, both the A and the B epoxy components shall be vacuum blended as to provide a non-compressible product, free of any air entrapment. The adhesive for injection shall be selected dependent upon crack width as described in Section 4.2, REPAIR PROCEDURE.

MATERIAL PROPERTIES OF EPOXY ADHESIVES FOR INJECTION

Property	CIA-GEL		
	Part A	Part B	Mixed Epoxy
Product	Epoxy Resin	Amine Adduct	100% True Epoxy
Color	Black Liquid	White Liquid	Concrete Gray Gel
Specific Gravity	1.21±0.1	1.74±0.1	
Flash Point	275°F/135°C	>200°F/93°C	
Viscosity (Brookfield)	16,000 cps @ 25 OC	23,500 cps @ 25°C	152,000 cps @ 25°C
Shelf Life	1 year minimum	1 year minimum	
Not sensitive to UV light or heat			

Heat Deflection Temperature	ASTM D648	144°F/62°C
Compressive Strength	ASTM D695	18,530 psi
Tensile Strength	ASTM D638	5,500 psi
Elongation	ASTM D229	0.57%
Shore D Hardness	ASTM 2240	90
Slant/Shear Strength	ASTM C882	6000 psi

All breaks in concrete, no failure along bond line

Product Meets ASTM C881-83 Types I, II, IV, & V, Grade 3, Classes B, C, D, E, & F

CIA-FLUID

Property	Part A	Part B	Mixed Epoxy
Product	Epoxy Resin	Amine Adduct	100% True Epoxy
Color	Black Liquid	White Liquid	Gray Liquid
Specific Gravity	0.7±0.1	0.4±0.1	
Flash Point	275°F/135°C	>200°F/93°C	
Viscosity (Brookfield)	13,000 cps @ 25°C	20,500 cps @ 25°C	5,100 cps @ 25°C
Shelf Life	1 year minimum	1 year minimum	
Not sensitive to UV light or heat			

Heat Deflection Temperature	ASTM D648	128°F/53°C
Compressive Strength	ASTM D695	18,530 psi
Tensile Strength	ASTM D638	5,250 psi
Elongation	ASTM D229	1.4%
Shore D Hardness	ASTM 2240	90
Slant/Shear Strength	ASTM C882	5000 psi

All breaks in concrete, no failure along bond line

Product Meets ASTM C881-83 Types I, II, IV, & V, Grade 2, Classes B, C, D, E, & F

CIA-INJECTION RESIN 7249

Property	Part A	Part B	Mixed Epoxy
Product	Epoxy Resin	Amine Adduct	100% True Epoxy
Color	Clear Blue Liquid	Clear Red Liquid	Clear Violet Liquid
Specific Gravity	1.1±0.1	0.4±0.1	
Flash Point	275°F/135°C	>200°F/93°C	
Viscosity (Brookfield)	1,025 cps @ 25°C	575 cps @ 25°C	438 cps @ 25°C
Shelf Life	1 year minimum	1 year minimum	
Not sensitive to UV light or heat			
Heat Deflection Temperature	ASTM D648	90°F/32°C	
Compressive Strength	ASTM D695	10,000 psi	
Tensile Strength	ASTM D638	3,800 psi	
Elongation	ASTM D229	1.0%	
Shore D Hardness	ASTM 2240	90	
Slant/Shear Strength	ASTM C882	5000 psi	
All breaks in concrete, no failure along bond line			

Product Meets ASTM C881 Types I & II, Grade 1, Classes B & C

Section 3.4 ADHESIVE FOR SURFACE SEAL AND PORT PLACEMENT

A. The epoxy adhesive used for the sealing of the crack surface and placement of injection ports shall comply with the following material specifications. Both the A and B epoxy components shall be vacuum blended as to provide a non-compressible product, free of any air entrapment. The adhesive for crack sealing and port placement shall be selected dependent upon the desired working and setting time of the adhesive. Consult data sheets for complete curing schedules to determine which product is best suited for each project. After the injection adhesive has cured, the surface seal must be capable of being removed or left in place.

**MATERIAL PROPERTIES OF EPOXY ADHESIVES FOR CRACK SEALING
AND PORT PLACEMENT**

CIA-GEL

Property	Part A	Part B	Mixed Epoxy
Product	Epoxy Resin	Amine Adduct	100% True Epoxy
Color	Black Liquid	White Liquid	Concrete Gray Gel
Specific Gravity	1.21±0.1	1.74±0.1	
Flash Point	275°F/135°C	>200°F/93°C	
Shelf Life	1 year minimum	1 year minimum	
Not sensitive to UV light or heat			

Compressive Strength	ASTM D695	18,530 psi
Tensile Strength	ASTM D638	5,500 psi
Elongation	ASTM D229	0.57%
Bond Strength	ASTM C882	3000 psi
Slant/Shear Strength	ASTM C882	6000 psi
All breaks in concrete, no failure along bond line		

Product Meets ASTM C881-83 Types I, II, IV, & V, Grade 3, Classes B, C, D, E, & F

CIA-CAP SEAL RS

Property	Part A	Part B	Mixed Epoxy
Product	Epoxy Resin	Polymercaptan	100% True Epoxy
Color	Black Liquid	Gel White Liquid	Gel Concrete Gray
Specific Gravity	1.32±0.1	1.91±0.02	
Flash Point	>200°F/93°C	185°F/85°C	
Shelf Life	1 year minimum	1 year minimum	
Not sensitive to UV light or heat			

Compressive Strength	ASTM D695	9,200 psi
Tensile Strength	ASTM D638	3,300 psi
Elongation	ASTM D229	0.2%
Bond Strength	ASTM C882	3000 psi
Slant/Shear Strength	ASTM C882	5000 psi

All breaks in concrete, no failure along bond line

Product Meets ASTM C881 Types I & II, Grade 1, Classes B & C

Section 3.5 PACKAGING, LABELING, STORAGE

A. Packaging: The adhesive material shall be packaged in new, sealed containers.

B. Label Information: The label shall include, in a clear and distinct manner, the following information:

1. Manufacturer name.
2. Product name, lot number, and date of expiration.
3. ANSI Hazard Classification (formerly SPI Classification) and appropriate recommended ANSI precautions for handling material.

C. Storage: The containers of the adhesive shall be stored at ambient temperatures below 120F and above 32 F. If stored at temperatures outside these limits, the adhesive material shall be tested at the Contractor's expense prior to use to determine if the adhesive material meets the requirements of this specification.

Part 4 Execution

Section 4.1 QUALIFICATIONS OF ADHESIVE APPLICATORS

A. Epoxy injection shall be performed by a certified applicator of the manufacturer of the epoxy meeting these specifications. The applicator shall be approved and trained by the epoxy manufacturer. Training curriculum shall consist of the theory behind the causes of cracking, selection of materials, and injection technology including flow rates, operating pressures, and temperature effects.

Section 4.2 REPAIR PROCEDURE

Cracks that are designated by the Engineer to be injected shall be cleaned and pressure injected with epoxy as specified. Some cracks and damaged areas may be determined to be excluded from repair by the field Engineer. Repair only those specifically identified by the Engineer to be repaired.

A. Crack Preparation

1. The licensed applicator shall be responsible for crack preparation. Determine the exact location and length of crack to be injected. If the crack walls are contaminated the crack should be opened slightly along its length with a small crack chaser blade. The crack and crack surface must be free and clean of loose matter and contaminants such as dirt, salts, efflorescence, oil, paint, debris, rust, laitance, etc. Surfaces adjacent to cracks or other areas of application shall also be cleaned of paint, dirt, dust, grease, oil, efflorescence, or other foreign matter detrimental to bond of epoxy injection surface seal system with the use of a grinding wheel, wire brush, and compressed air. Acids and corrosives shall not be permitted for cleaning, unless neutralized.
2. It is recommended that the concrete be dry during the crack repair process. Water will not significantly affect the bond strength of the epoxy but may hinder proper movement and penetration through the crack. If water migration through the crack is an issue, the water source must be identified and contained during the installation. Displacement of epoxy can occur from hydrostatic pressure and disrupt the bonding process. Contaminated water/rainfall can discolor surface epoxy if in contact before the curing process is complete but will not affect bond strength.

B. Port Placement

1. Determine the thickness of the member to be injected and mark the crack along its length for port placement. Spacing is recommended to be not less than the thickness of the member to be repaired. Port spacing should be increased accordingly for complete injection penetration if it is found that the crack width at the surface is larger than at the bottom of the crack. Additionally, closer spacing may be specified for injection of very fine cracks or varied slightly in locations where the most open spots occur and/or where the geometry changes on the crack.
2. For cracks extending entirely through the member, ports only need to be placed on one side. If the crack extends through the member and the backside cannot be sealed, reduce entry port spacing to 80% and use the highest viscosity epoxy the crack will accept. There is a possibility that there will not be flow from port to port since there is no seal on the back side of the crack, therefore discretion must be used so that only a minimum amount of injection adhesive is lost out of the backside or into the soil.

3. At each marked location, adhere a port over the crack using the CIA-Gel epoxy. Insure that the open portion of the crack is visible through the port entry and that none of the epoxy being used to attach the port has blocked the opening. This can be done visually by looking down the nose of the port. Blow air into each of the ports to be sure the port and/or crack is not blocked. Perform this test for each of the ports.

*For each specific field condition, judgment and experience should always factor into decisions for proper port placement.

C. Crack Cap Sealing

1. Using the specified epoxy, place a bead of epoxy over the flange of the port completely so that it is no longer visible. Tool the bead over the port flange and crack length with a putty knife to assure that there are no pin-holes or voids where resin could escape under pressure. Repeat this procedure of sealing between the ports and along the entire length of the crack to complete the seal. Allow the surface seal epoxy to harden properly before proceeding with injection.
2. If the crack extends through the member being repaired, the backside of the member must be sealed. The procedure for sealing the backside of the crack is the same as above except that ports are not used since the member needs only to be injected from one side. As above, allow the surface seal epoxy to harden properly before proceeding with injection.

D. Material Selection for Injection

1. Determine which epoxy viscosity best suits the crack to be repaired (recommendations are for epoxies at 70°F):

For crack widths up to 1/8" choose CIA-INJECTION RESIN
For crack widths between 1/8" to 3/8" choose CIA-FLUID EPOXY
For crack widths of 3/8" and above choose CIA-GEL EPOXY

2. All Covert epoxies are compatible with each other. Epoxy viscosity can be modified slightly by altering the temperature of the product (heating will thin epoxy and cooling will thicken epoxy).

E. Application and Injection

1. Resin and hardener are packaged in a single piece side-by-side cartridge. The two components are dispensed and mixed simultaneously through a static-mixing nozzle. Hold the epoxy cartridge upright and remove the cap and plug. Attach the required diameter staticmixer nozzle to the end of the cartridge and secure with retaining nut. Attach a length of clear flexible tubing onto the end of the mixer if necessary due to access and/or space restrictions. Insert the cartridge into a hand or pneumatic powered tool.

2. For use with the pneumatic injection tool at 70°F, the recommended air pressure into the tool is as follows:

CIA-INJECTION RESIN - Set inlet pressure between 30 to 50 psi

CIA-FLUID EPOXY - Set inlet pressure between 50 to 70 psi

CIA-GEL EPOXY - Set inlet pressure between 70 to 90 psi

3. Dispense a small amount of epoxy through the mixing nozzle until a uniform color is achieved and the cartridge is equalized. Keep a slight amount of pressure on the cartridge after dispensing has begun. This will prevent resin from flowing back into the cartridge in any intermediate times during the injection process.
4. Attach the end of the mixing nozzle or flexible tubing with adapter into the seat of the injection port. Interlocking the port connection will prevent leakage during the injection process. Beginning with the first port, or the lowest port on all vertical surfaces, begin the flow of epoxy. Continue injection of the crack through the port observing for any leaks.
5. When epoxy appears at the next port, remove the nozzle or hose from the port being injected and insert the port plug. Move to the next port and restart the epoxy flow into the crack. Continue and repeat the process until the last port is reached. Inject epoxy into the last port until the crack will no longer accept any more material. Allow epoxy to cure before performing any finishing procedures.
6. Full penetration of cracks should be achieved. It may be appropriate for the contractor to take small cored samples of the injected areas to show full penetration.

Section 4.3 FINISHING

- A. After the injection adhesive has cured, the surface seal can be removed for aesthetic purposes. The surface seal and entry ports shall be removed by grinding or a flat chisel until the surface is flush with the surrounding areas. Heating of the surface seal with a torch to aid in the removal shall not be allowed since it may jeopardize the injected adhesive. The surface seal and ports may be left in place if desired.

B. Surface seal material and injection adhesive runs or spills shall be removed from surrounding area. Clean up of uncured material with cotton cloth or approved cleaning compound is recommended.

Section 4.4 MATERIAL ESTIMATION

A. Crack cap seal material - Each 21 fl oz side-by-side cartridge contains enough material to seal approximately 50 feet.

B. Injection material - Volume of product for injection required can be calculated in cubic inches is as follows:

$$(\text{width of the crack}) \times (\text{length of the crack}) \times (\text{depth of the crack})$$

Each 21oz cartridge yields 37.9 cubic inches. The number of cartridges required is the amount of material needed divided by the yield of the cartridge. An estimating guide for crack injection is included for reference below.

ESTIMATING GUIDE FOR CRACK INJECTION

Width of Crack (Inches)	Concrete Thickness (Inches)	Coverage per 21 oz. Cartridge (Linear ft.)	Width of Crack (Inches)	Concrete Thickness (Inches)	Coverage per 21 oz. Cartridge (Linear ft.)	Width of Crack (Inches)	Concrete Thickness (Inches)	Coverage per 21 oz. Cartridge (Linear ft.)
1/128	4	101.1	1/8	4	6.3	3/8	4	2.1
	6	67.4		6	4.2		6	1.4
	8	50.5		8	3.2		8	1.1
1/64	4	50.5	3/16	4	4.2	7/16	4	1.8
	6	33.7		6	2.8		6	1.2
	8	25.3		8	2.1		8	0.9
1/32	4	25.3	1/4	4	3.2	1/2	4	1.6
	6	16.8		6	2.1		6	1.1
	8	12.6		8	1.6		8	0.8
1/16	4	12.6	5/16	4	2.5	9/16	4	1.4
	6	8.4		6	1.7		6	0.9
	8	6.3		8	1.3		8	0.7

Coverage listed is based on exact volumetric calculations and will vary depending on waste and condition of concrete. No allowances have been factored in.

Section 4.5 ALTERNATE INJECTION METHODS: Bulk Injection Equipment

Occasionally, due to the size and nature of crack injection projects, applications with bulk dispensing equipment are allowed. If bulk injection equipment is selected as the appropriate means of injection, the instructions and specifications below will replace Section 3.2 and Section 4.2, Part E, Steps 1, 2, and 3.

- A. The specified injection resin (same selection criteria as above) shall be placed in equipment possessing positive displacement-type pumps with interlock to provide positive ratio control of exact proportions of the two components of the epoxy resin adhesive at the nozzle. The pumps shall be electric or air powered and shall provide an in-line mixing and metering system. The injection equipment shall have automatic pressure control capable of discharging the mixed adhesive at any pre-set pressure up to 200 psi.
- B. The equipment shall have the capability of maintaining the volume ratio for the injection adhesive prescribed by the manufacturer of the adhesive within a tolerance of plus or minus 5% by volume at any discharge pressure of up to 200 psi.
- C. The injection equipment shall have sensors on both the components A and B reservoirs that will automatically stop the machine when only one component is being pumped to the mixing head.
- D. The equipment shall be tested after every four hours of use and at the beginning of each shift for the proper injection ratio of components. The mixing head of the injection equipment shall be disconnected and the two adhesive components shall be pumped simultaneously through the ratio check device. The ratio check device shall consist of two independent valved nozzles capable of controlling backpressure by opening or closing the valve. There shall be a pressure gauge capable of sensing the backpressure behind each valve. The discharge pressure shall be adjusted to 160 psi for both adhesive components. Both adhesive components shall be simultaneously discharged into separate calibrated containers. The amounts discharged simultaneously into the calibrated containers shall be compared to determine the volume-discharged conformance to the manufacturer's recommended ratio for the appropriate material.
- E. At all times during the course of the work the contractor shall keep and complete accurate records available to the engineer of the pressure and ratio test specified above.