

ITEM 11555.8005 M - CRACK SEALING BY VACUUM INJECTION/IMPREGNATION PROCESS

1.0 DESCRIPTION

This work shall consist of providing all labor, materials, equipment, and services necessary to seal cracks using the vacuum injection/impregnation process in accordance with these specifications, at the locations shown on the plans, and as ordered by the Engineer.

2.0 MATERIALS

2.1 Crack Injection Material. Crack injection material shall conform to the following:

2.1.1 Low Viscosity Epoxy Resin: Fox Fx 770 manufactured by Fox Industries, 300 Falls Cliff Road, Baltimore Md. 21211 or approved equal. Applicable over ambient and placement temperature range between 15°C to 32°C, or other temperature range approved by the manufacturer and/or the Engineer.

2.1.2 Low Viscosity Methyl Methacrylate (MMA) Resin: Fox 821 manufactured by Fox Industries, or approved equal. Applicable over ambient and placement temperature range between 0°C to 33°C or temperature range approved by the manufacturer and/or the Engineer.

2.1.3 High Molecular Weight Methacrylate (HMWM): 5740 High Mod (for exterior application) manufactured by 3M Construction Markets, 3M Bldg. 225-4S-08, St. Paul, MN 55144-1000, or approved equal. Applicable over ambient and placement temperature range between 0°C (32°F) to 35°C (95°F), or other temperature range approved by the manufacturer and/or the Engineer. (Cure time will be significantly affected by the temperatures).

2.1.4 Resins will be thickened with Cabsoil, silica fume dust, Portland cement, or other inert material approved by resin manufacturer as required to fill large voids and cavities encountered within the members up to 15mm wide

2.2 Injection Ports. Injection Ports shall be metal or plastic injection tubes mounted to the concrete surface or inside predrilled holes and connected to injection hoses.

2.3 Epoxy Adhesive. Epoxy adhesive to secure injection ports to concrete surfaces shall be as recommended by the supplier of the vacuum impregnation system..

2.4 Surface Seal. The surface seal shall be as recommended by the supplier of the vacuum impregnation system and shall show adequate strength and adhesion to hold injection ports firmly in place and to prevent leakage of repair material during vacuum injection. The seal shall be removable without damaging or defacing structure being repaired.

2.5 Cleaning materials. Water shall be as per Material Specification 712-01. Brushes shall be fiber bristle only. Solvent cleaner to be Methyl Ethyl Keytone (MEK). Toluene or approved equal shall be used unless restricted by air quality regulations.

3.0 CONSTRUCTION DETAILS

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3.1 Submittals. 30 days prior to the start of the work, and after surface cleaning, the Contractor shall submit three copies of the following to the Engineer for approval:

3.1.1 All product data including the manufacturer's specifications and installation instructions for repair material and surface seal materials. The contractor shall supply independent laboratory testing reports to the Engineer to certify that material meets or exceeds the material specified herein.

3.1.2 US Department of Labor, Material Safety Data Sheets on all hazardous chemical products proposed for use during the work of these items. Copies to be filed with the Engineer.

3.1.3 Shop drawings and captioned photographs clearly depicting conformance with the injection/impregnation process as defined on the plans and in these specifications, including typical vacuum system preparation, instrumentation, gauging, and detailed line configurations from material container source to point of repair entry.

3.1.4 Shop drawings showing all existing cracks indicating crack number and crack length. Port pattern layout plan, installation details, work schedule, equipment details and injection port removal details. Port pattern is defined as the layout and predetermined angles for drilling through the concrete and placing injection ports.

3.1.5 Manufacturer's certification that materials meet or exceed specification requirement, including certified laboratory test reports, as necessary, from independent laboratories confirming that materials meet the specified requirements.

3.1.6 Manufacturer's Instructions: Manufacturer's literature, specifications, product handling, application instructions and safety requirements.

3.1.7 Procedures to be employed including a schedule of the personnel, equipment, methods, materials, proposed phasing of the project and a construction schedule indicating the expected start and completion date of each phase.

3.1.8 Contractor's Guarantee. The contractor shall provide a five year written guarantee covering defects in materials and workmanship.

3.1.9 Manufacturer's Warranty. In addition to the Contractor's guarantee, the contractor shall furnish the material manufacturer's printed five-year warranty for the work of these items. The warranty shall include, but not be limited to, repair of leakage caused by defects in materials or workmanship in areas of repair. The monetary value of the warranty shall be at least equal to the original cost of the installation.

3.2 Standards and Qualifications

3.2.1 Standards. The Contractor shall comply with the following ASTM Standards:

ASTM C39 Standard test for compressive strength of cylindrical concrete specimen

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| ASTM C144 | Standard specifications for aggregates for masonry mortar |
| ASTM C150 | Standard specifications for Portland Cement |
| ASTM C207 | Standard specifications for Hydrated Lime for masonry |
| ASTM C307 | Standard test for tensile strength of chemical-resistant mortar, grout and monolithic surfaces |
| ASTM D695 | Standard specifications for compressive properties of rigid plastics |
| ASTM D696 | Test method for coefficient of linear thermal expansion of plastics |
| ASTM D790 | Test method for flexural properties of unreinforced and reinforced plastics and electrical insulating materials |
| ASTM C881 | Standard specifications for epoxy resin base for concrete |
| ASTM C882 | Standard test method for bond strength of epoxy resin used with concrete by slant shear |
| ASTM D2393 | Test method for viscosity of resins and related components |
| ASTM D2566 | Test method for linear shrinkage of cured thermosetting casting resins during cure |

3.2.2 Qualifications of the Contractor. The contractor shall have a minimum of 5 years verifiable experience in the vacuum/impregnation process and shall have completed at least two repair projects of similar design and construction which have proven successful for a minimum of three years.

3.2.3 Qualifications of Personnel. The contractor shall provide personnel to perform the vacuum injection/impregnation techniques specified herein who have experience in the successful repair of structures using vacuum methods, and are thoroughly familiar with the technical aspects of correct material usage, and the operation, maintenance and checking of vacuum equipment. All personnel employed on the vacuum injection/impregnation work are to hold a current certification by the supplier of the vacuum impregnation system.

3.2.4 Manufacturer's Representative: The contractor shall provide for the services of the injection/impregnation material manufacturer's representative to be present continuously during the vacuum process until such time the representative is satisfied with the performance of the application. Then, the material manufacturer's representative must visit the site periodically to monitor the injection operations. Everyday after monitoring the operation, the representative must verify that the material and application techniques are in compliance with the requirements of the manufacturer and submit a certificate to the Engineer.

3.4 Product Delivery, Handling and Storage. The contractor shall deliver materials to the job site in their original unopened containers clearly labeled with the manufacturer's name and product designation, lot number, shelf life, type and class of the product in a manner to prevent damage by breakage, water and moisture or any other contamination.

The contractor shall store materials in strict accordance with manufacturer's printed instructions so as to prevent damage, water intrusion, dampness, contamination, freezing, and/or excessive heat.

The contractor shall follow manufacturer's safety requirements for handling.

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3.5 Placement of Crack Sealing Apparatus

3.5.1 Inspect the surface to adequately assess the condition of each area to be repaired.

3.5.2 Mobilize materials and equipment to the site.

3.5.3 Brush clean, or sand blast and vacuum all cracks and adjacent surfaces to remove loose material, dust, dirt, grease, oil, efflorescence and other foreign matter that would inhibit bonding of resin to concrete. Care must be used when cleaning with compressed air so as not to clog crack openings with foreign matter.

3.5.4 Prepare the crack location plan for all cracks including the ones that become visible after surface cleaning operations. A copy of the crack location plan shall be submitted to the Engineer.

3.5.5 After drilling for ports, if necessary, install injection ports on the concrete surface by means of epoxy adhesive and according to the approved injection port layout plan.

3.5.6 Apply surface seal material to the entire concrete surface including the cracks, and between the vacuum ports to prevent the escape of injected materials and to create a closed system. Where through cracks exist in the member, apply seal to both sides where accessible. Allow sufficient time for the surface seal material to gain adequate strength before proceeding with the vacuum injection/impregnation process.

3.5.7 Check surface seal leak by applying a soap and water solution to the concrete surface and air pressure through the injection ports to observe forming of bubbles at the surface. Reseal locations of pressure leak and recheck.

3.5.8 Where cracks are through cracks, but access to both sides of the crack is unavailable, Contractor shall seal the back of the crack using one of the following techniques, or other method approved by the engineer.

- A. Drill an access hole(s) and apply a sealer to the back (inaccessible) side of the crack.
- B. Inject a sealant at a positive pressure of 2-5 psi, while at the same time drawing a vacuum directly above the sealant line to draw the sealant into the back (inaccessible) side of the crack
- C. Drill a hole and inject a foam sealant into the cavity at the back (inaccessible) side of the crack
- D. If an initial low level of vacuum is achieved, use an accelerated set time for the repair resin to fill the crack from the back (inaccessible) side of the crack to the front (accessible) side.

3.6 Crack Sealing

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3.6.1 Install clear tubing to each vacuum port. The tubes shall be connected to a common vacuum manifold which in turn will be connected to a vacuum source. Apply vacuum to the closed system.

3.6.2 Perform a continuity check by applying vacuum at one port and closing all other ports, then opening the closed ports one port at a time and observe vacuum loss from it. Continue the same process to ensure continuity.

3.6.3 Begin vacuum evacuation process and start drying the moisture from the internal network of cracks, then continue drying as ordered by the Engineer. Continue vacuum evacuation and moisture drying until the relative humidity of the effluent air is 75% or less than the relative humidity of the ambient air as measured by in-line hygrometers.

3.6.4 Prepare material for injection in ½ or 1 liter bottles with appropriate caps and connections designed to maintain a sealed/contained source. Ensure that the resin materials mixed be limited to a quantity that can be consumed in the immediate repair area.

3.6.5 Maintain vacuum and release the approved repair materials into the enclosed system through the vacuum ports, one port at a time while observing the adjacent port for flow of materials.

3.6.6 Once the material is observed flowing from the adjacent ports, close the injected port and install vacuum tubes at the next adjacent port and continue injecting repair material.

3.6.7 Continue the operation as required for the entire structure to be repaired, to the extent shown on the plans..

3.6.8 The crack is considered filled if the level of the repair materials stays steady for 5 to 15 minutes or as instructed by the injection materials representative.

3.6.9 The contractor shall remove surface seal and vacuum port fittings when repair materials have sufficiently cured to allow removal without disturbing the cured resin as ordered by the engineer.

3.7 Quality Control, Record Keeping and Testing

3.7.1 All operations and application of all materials shall be in accordance with the recommendations of the vacuum system supplier.

3.7.2 The Contractor shall keep a daily log documenting each crack number, the quantity of repair material introduced into it, the sequence of injected ports and the vacuum (negative pressure) value at the pump. A copy of the log to be submitted to the Engineer at the end of each workday.

3.7.3 The Contractor shall mix all materials in accordance with the manufacturer's recommendations.

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3.7.4 The Contractor, at the direction of the Engineer, shall employ Impact-Echo testing after repairs are made to verify the level of success of the repairs.

3.7.5 The Contractor shall extract one (1) 100 mm diameter core for every 30 meters of discrete crack seal or as ordered by the Engineer to verify the success of the crack sealing operation. The contractor shall visually inspect the cores to ensure that the cracks are filled with the cured injected material and perform compressive and shear tests as specified in ASTM C39 and ASTM C881. The contractor shall record the results of all tests and furnish a copy of the results to the Engineer prior to proceeding with the rest of the work. The contractor shall remedy any defects identified by the Impact-Echo test or the taken concrete cores to the satisfaction of the Engineer.

3.7.6 Patching Core Holes and Cleanup. The contractor shall patch core holes by filling with approved cement concrete filler or other acceptable materials to the satisfaction of the Engineer. The contractor shall remove adhesive runs and spills from existing surfaces in a manner that shall not deface the surfaces being cleaned. The contractor shall maintain a clean and tidy site at all times and shall remove all debris related to the work from the site at completion.

4.0 METHOD OF MEASUREMENTS

The quantity of the hot applied waterproofing membrane to be paid shall be defined as the number of linear meters of cracks successfully sealed by the vacuum injection/impregnation process. Where through cracks are repaired on both surfaces and injected from either one or both surfaces, measurement shall be made of the total length of cracks repaired on both surfaces.

5.0 BASIS OF PAYMENT

The unit price bid shall include the cost of furnishing labor, materials, equipment and services to satisfactorily complete the crack sealing by vacuum injection/impregnation process, including testing and concrete coring.