

QUADEX MANHOLE RESTORATION MATERIALS INSTALLATION SPECIFICATION

For Restoration Using Quadex Cementitious Materials

1.0 GENERAL

- 1.1 These specifications are intended to set a standard of quality and design for the application of all cementitious materials used in the rehabilitation of manholes.
- 1.2 All materials must be approved by the engineer or owner prior to job bid.

2.0 DEFINITIONS

- 2.1 The term "approved" shall mean that the proposed material shall meet or exceed each of the performance criteria set forth in this specification. Manufacturers and vendors of various name brand materials must submit proof that any proposed material will meet the guidelines and requirements of this specification. The engineer or owner will make final approval of any proposed material.

3.0 APPROVED MATERIALS

3.1 Infiltration Control

All fast setting materials furnished shall be designed to be applied in dry powder form, with no prior mixing of water, directly to active leaks under hydrostatic pressure in manholes or related structures. Materials shall consist of rapid setting cements, silicious aggregates, and various accelerating agents. Material shall not contain chlorides or metallic particles. Approved infiltration control material shall be Quadex Quad-Plug as manufactured by Quadex, Inc., Maumelle, Arkansas.

3.1.1 Specifications: Infiltration Control Materials

- A. Compressive Strength (ASTM C109)
 - 30 mins: 1850 psi
 - 3 days: 4000 psi
 - 7 days: 5000 psi
 - 28 days: 5890 psi
- B. Bond Strength (ASTM C321)
 - 30 min: 50 psi
 - 1 day: 85 psi
- C. Set Time 30 seconds

3.2 Invert Repair and Patching

All material furnished shall be designed to fill large voids in manhole walls and to repair or reconstruct inverts where no hydrostatic pressure exists. Material shall consist of rapid setting cements, monocrySTALLINE quartz aggregates, and various accelerating agents. Material shall not contain chlorides or metallic particles. Approved invert repair and patching material shall be Quadex Hyperform as manufactured by Quadex, Inc., Maumelle, Arkansas.

3.2.1 Specifications: Repair and Patching Materials

- A. Compressive Strength (ASTM C109)
 - 1 hour: 4170 psi
 - 3 hours: 5840 psi
 - 24 hours: 7660 psi
- B. Flexural Strength (ASTM C348)
 - 1 hour: 450 psi
 - 3 hours: 625 psi
 - 24 hours: 820 psi
- C. Freeze-Thaw (ASTM C666)
 - 300 cycles with no damage
- D. Setting Time (Gilmore ASTM C266)
 - Initial 15-18 minutes
 - Final 22-25 minutes

3.3 Cementitious Coating (Liner) Materials for Manhole Walls and Benches

All cementitious coating (liner) materials shall be specifically designed for the rehabilitation of manholes and other related wastewater structures. Liner materials shall be cement based, poly-fiber reinforced, shrinkage compensated, and enhanced with chemical admixtures and siliceous aggregates. Liner materials shall be mixed with water per manufacturer's written specifications and applied using equipment specifically designed for either low-pressure spray or centrifugal spin casting application of cement mortars. All cement liner materials must be capable of a placement thickness of ½" to 4" in a one pass monolithic application.

3.3.1 Specifications: Cementitious Coating Materials

3.3.2 Physical Properties

All cementitious coating materials shall conform to the following 28-day minimum physical properties.

- A. Compressive Strength (ASTM C109)
 - 9500 psi
- B. Flexural Strength (ASTM C293)
 - 1400 psi
- C. Bond Strength (ASTM C882)
 - 1500 psi

- D. Permeability (AASHTO T-277)
Not to exceed 400 coulombs
- E. Freeze-Thaw (ASTM C666)
No damage in minimum 300 cycles
- F. Material Wet Density
Minimum 140 PCF

3.3.3 Material Design

All cementitious coating materials shall be approved for use based upon the following design conditions.

- A. Low to mild hydrogen sulfide environments (pH > 2.0)

Cementitious coating materials shall be manufactured from Type II portland cement, and enhanced with silica fume. Materials shall contain poly-fiber reinforcement, chemical admixtures, and siliceous aggregates. Approved material shall be Quadex QM-1s Restore as manufactured by Quadex, Inc., Maumelle, Arkansas.

- B. Extremely harsh hydrogen sulfide environments (pH < 2.0)

Cementitious coating materials shall be manufactured from 100% pure calcium aluminate cement and enhanced with high-density chemically stable aggregates. Materials shall contain poly fiber reinforcement and chemical admixtures. Approved material shall be Quadex Aluminaliner as manufactured by Quadex, Inc., Maumelle, Arkansas.

4.0 Interior Manhole Rehabilitation

4.1 Manhole Cleaning and Preparation

The floor and interior walls of the manhole shall be thoroughly cleaned and made free of all foreign materials including dirt, grit, roots, grease, sludge and all debris or material that may be attached to the wall or bottom of the manhole.

- A. High pressure water blasting with a minimum of 3500 psi shall be used to clean
Free all foreign material within the manhole.
- B. When grease and oil are present within the manhole, an approved detergent or muriatic acid shall be used integrally with the high pressure cleaning water.
- C. All materials resulting from the cleaning of the manhole shall be removed prior to application of the cement based coating.
- D. All loose or defective brick, grout, ledges, steps and protruding ledges shall be removed to provide an even surface prior to application of cement based coating.

4.2 Sealing Active Leaks

The work consists of hand applying a dry quick-setting cementitious mix designed to instantly stop running water or seepage in all types of concrete and masonry structures. The applicator shall apply material in accordance with manufacturer's recommendations and following specifications.

- A. The area to be repaired must be clean and free of all debris per the guidelines set forth in section 4.1 Manhole Cleaning and Preparation.
- B. Once cleaned, prepare crack or hole by chipping out loose material to a minimum depth and width of $\frac{3}{4}$ inch.
- C. With gloved hand, place a generous amount of the dry quick-setting cementitious material to the active leak, with a smooth fast motion, maintaining external pressure for 30 seconds, repeat until leak is stopped.
- D. Proper application should not require any special mixing of product or special curing requirements after application.

4.3 Invert Repair

The work consists of hand mixing and applying a rapid setting, high early strength, non-shrink patching material to fill all large voids and repair inverts prior to spray lining of the manhole. For invert repairs, flow must be temporarily restricted by inflatable or mechanical plugs prior to cleaning.

- A. The area to be repaired must be cleaned and free of all debris per the guidelines set forth in section 4.1 Manhole Cleaning and Preparation.
- B. Mix water shall be clean potable water and require no additives or admixtures for use with cementitious patching materials.
- C. Cementitious material shall be mixed in a mortar tub or 5 gallon pail with water per manufacturer's specifications. Material should be mixed in small quantities, to avoid setting prior to placement in voids or inverts.
- D. Once mixed to proper consistency, the materials shall be applied to the invert or void areas by hand or trowel. In invert applications, care should be taken to not apply excessive material in the channel, which could restrict flow. Once applied, materials should be smoothed either by hand or trowel in order to facilitate flow.
- E. Flows in inverts can be reestablished within 30 minutes of material placement.

4.4 Application of Cementitious Manhole Liner

The work consists of spray applying and / or centrifugally spin casting a cementitious based liner to the inside of the existing manhole. The necessary equipment and application methods to apply the cementitious based liner materials shall be only as approved by the material manufacturer.

- A. Material shall be mixed with water in accordance with manufacturer's specifications. Once mixed to proper consistency, the materials shall be pumped via a rotor-stator style progressive cavity pump through a material plaster hose for delivery to the appropriate and / or selected application device.
- B. Spray application of the cementitious material.
 - a. Material hose shall be coupled to a low-velocity spray application nozzle. Pumping of the material shall commence and the mortar shall be atomized by the introduction of air at the nozzle, creating a low-velocity spray pattern for material application.
 - b. Spraying shall be performed by starting at the manhole invert and progressing up the wall to the corbel and chimney areas.
 - c. Material shall be applied to a specified uniform minimum thickness no less than ½ inch. Material shall be applied to the bench area in such a manner as to provide for proper drainage without ponding.
- C. Centrifugal spin casting application of the cementitious material.
 - a. Material hose shall be coupled to a high speed rotating applicator device. The rotating casting applicator shall then be positioned within the center of the manhole at either the top of the manhole chimney or the lowest point elevation corresponding to the junction of the manhole bench and walls.
 - b. The high speed rotating applicator shall then be initialized, and pumping of the material shall commence. As the mortar begins to be centrifugally cast evenly around the interior of the manhole, the rotating applicator head shall be raised and / or lowered at a controlled retrieval speed conducive to providing a uniform material thickness on the manhole walls.
 - c. Controlled multiple passes are then made until the specified minimum finished thickness is attained. If the procedure is interrupted for any reason, simply arrest the retrieval of the applicator head until flows are recommenced.
 - d. Material thickness may be verified at any point with a depth gauge and shall be no less than a uniform ½-inch . If additional material is required at any level, the rotating applicator head shall be placed at that level and application shall recommence until that area is thickened.
- D. Material shall be applied only when manhole is in a damp state, with no visible water dripping or running over the manhole walls.
- E. The low-velocity spray nozzle and the centrifugal spin casting head may be used in conjunction to facilitate uniform application of the mortar material to irregularities in the contour of the manhole walls and bench areas.

- F. Troweling of materials shall begin immediately following the spray application. Initial troweling shall be in an upward motion, to compress the material into voids and solidify manhole wall. Precautions should be taken not to overtravel.
- G. Curing will take place once the manhole cover has been replaced. It is important that the manhole cover is replaced no more than 10-20 minutes after troweling is complete to avoid moisture loss in the material due to sunlight and winds.
- H. Material shall not be applied during freezing weather conditions. Material shall not be placed when the ambient temperature is 37 degrees Fahrenheit and falling or when the temperature is anticipated to fall below 32 degrees Fahrenheit during 24 hours.

5.0. QUALITY CONTROL

The quality and performance of the material shall be maintained by one or all of the following measures to be determined and specified by the engineer or owner.

5.1 Performance Testing

- A. Vacuum Testing
- B. Exfiltration Testing
- C. Visual Inspection

5.2 Material Testing

One 2 X 2 inch sample cube shall be taken for every 50 bags of material used. Samples shall be sprayed from nozzle, identified and sent to an independent test laboratory for compression strength testing as described in ASTM C-109.

6.0 WARRANTY

Product manufacturers shall warrant all materials to be free of defects product design and workmanship for a period of one year from date of purchase. Manufacturer will provide replacement materials for any product proven to be defective when applied in accordance with manufacturer's recommendations. Manufacturer's obligation shall be limited solely to product replacement.