

Standard Practice for Installing a Protective Calcium Aluminate Cement Liner System In Sanitary Sewer Infrastructures

INTRODUCTION

In sewer manhole rehabilitation, a pure-fused **CALCIUM ALUMINATE CEMENT** is used to form a monolithic, high performance, corrosion resistant liner coating to restore structural integrity, stop water infiltration and withstand hydrogen sulfide corrosion in manholes and sewage works. The application includes partial depth repair and full depth restoration. The cement mortar mixture shall be used where harsh hydrogen sulfide conditions exist in the sewer system; and shall meet the American Association of State Highway and Transportation Officials; AASHTO HS-20 Traffic Loading Standard.

1.0 - GENERAL REQUIREMENTS

- A. The specification shall govern all the labor, materials, and equipment required for the purpose of restoring structural integrity in sewer manholes, pipes, lift stations, and water treatment plant structures. The cement is a ready-to-use mortar for new and existing construction repairs and protection against corrosion [and provides hydraulic abrasion resistance]. Apply the cement liner material to the interior concrete and brick surfaces within the structure.
- B. This standard does not purport to address all of the safety concerns associated with its use. It is the responsibility of the user to establish appropriate health and safety practices and to determine the applicability, environmental and limitations prior to use.

1.1 ASTM STANDARDS

- A. ASTM C 150 Standard Specifications for Portland Type I
- B. ASTM C 33-86 Standard Specifications for Concrete Aggregates
- C. ASTM C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens
- D. ASTM C 78 Standard Test Method for Flexural Strength of Concrete; Using Simple Beam with Third Point Loading
- E. ASTM C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (2-in Cubes).
- F. ASTM C 267 Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfaces and Polymer Concretes.
- G. ASTM C 309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete
- H. ASTM C 321 Test Method for Bond Strength of Chemical-Resistant Mortars

- I. ASTM C 494-86 Standard Specification for Chemical Admixtures for Concrete
- J. ASTM C 49C/ 49M Test Method for Splitting Tensile Strength Cylindrical Concrete Specimens
- K. ASTM C 1140-03 Standard Practice for Preparing and Testing Specimens from Shotcrete Test Panels
- L. ASTM C 882 Test Methods for Bond Strength of Epoxy Coatings Used With Concrete by Slant Shear
- M. ASTM C 1107-05 Standard Specification for Packaged, Dry, Hydraulic Cement Grout

1.2 ACI STANDARDS

- A. ACI 201.2R-93 Guide for Durable Concrete
- B. ACI 302 Guidelines for Concrete Floors and Slab Construction
- C. ACI 308 Practice for Curing Concrete
- D. ACI 302 Guidelines for Concrete Floors and Slab Construction

1.3 DEPARTMENT OF TRANSPORTATION STANDARDS

- A. AASHTO T-277; Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
- B. AASHTO HS 20 Traffic Loading Guide; American Association of State Highways and Transportation Officials.

1.4 SUBMITTALS

A. Product Data:

1. Technical product data on each product; include brand name and manufacturer. Provide 28-day compressive strength test results in accordance with the requirements specified herein. Provide satisfactory conformance to ASTM C 267; Chemical Resistance of Mortars, Grouts and Monolithic Surfaces test results.
2. Provide a product certification stating the chloride ion content of the cement.

B. Contractor Requirements:

1. Provide a manufacturer's certification verifying the applicator has been trained [approved] for handling and mixing (inspection) of the product(s) to be used.
2. Give name of (3) recent references indicating successful application of the cement product(s) within a municipal wastewater environment in a similar region.
3. The approved applicator shall furnish all of the labor, equipment and materials to rehabilitate the manhole. The application equipment shall be capable of spraying the cement as required by the manufacturers printed recommendation.

4. The applicator shall use a Sewer Manhole Masters® Repair Trailer [or approved equal] to apply the cement.

C. QUALITY CONTROL

1. Provide a Manufacturers Process, Applicator Requirements, and Quality Control measures that meets applicable ASTM, NACE and SSPC inspection standards. The applicator shall follow and enforce quality control procedures consistent with the manufacturer’s recommendation.
2. The engineer will approve the procedure before start up.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store the cement products dry, under cover and protected from weather.

2.0 PRODUCTS

2.1 PATCHING MATERIAL

- A. Fast Set Bench Mix—a fast setting, corrosion resistant cementitious material. Use the FSR™ cement [hand-mixed] as a patching material to repair cracks, fill voids and to reform bottoms, and to adjust height and create benches in manholes. Mix the FSR™ Cement with cold, potable water for approximately 1-minute; apply with a trowel and finish to a smooth surface. Keep the patch damp with water or cover with a damp cloth. Protect from freezing, hot temperatures and wind extremes.

Physical Property Requirements:

Property		psi		
Compressive Strength	ASTM C 109	24-hr 3,500	7-day >6,000	28-day >8,000
Bond Strength	ASTM C 321	> 140		
Shrinkage	ASTM C 596	0% at 90% RH		
Cement		Sulfate resistant		
Applied Density		120 ± 5		

B. INFILTRATION CONTROL MATERIAL

1. Custom Plug Cement—a fast setting, hydraulic cement product specifically formulated for infiltration control and to stop minor water leaks instantly. Use the CP Cement to stop seepage in concrete and masonry structures. Apply it in dry form directly to the leak area or mixed with potable water in a soft putty-like consistency for larger leaks. The CP Cement sets in 60 to 90 seconds.

Physical Property Requirements:

Property		psi		
Compressive Strength	ASTM C 109	24-hr 3,500	7-day >4,900	28-day >5,500
Split Tensile Strength	ASTM C 496	200	*	560

Volume Change	ASTM C 827	0%
Freeze Thaw Durability	ASTM C 666	No loss after 100 cycles
Placement Time		60 to 90 seconds

C. CEMENT LINER MATERIAL

1. The Maximum CA™ Cement—is a packaged, factory blended pure fused calcium aluminate cement mixture. The corrosion resistant cement shall be used to form a structural liner coating for the manholes interior surfaces.

Physical Property Requirements:

Property		psi
Compressive Strength	ASTM C 109	28-day >9,000
Flexural Strength	ASTM C 293	1,360
Split Tensile Strength	ASTM C 496	650
Shrinkage at 90% RH	ASTM C 596	<0.03%
Freeze Thaw -300 Cycles	ASTM C 666	No damage
Bond Strength/ Slant Shear	ASTM C 882	1,765
Sulfate Resistance-90 days	ASTM C 267	No Loss
Chloride Permeability	AASHTO T 277	300
Applied Density		127 ± 2

D. Water—Use clean, potable water.

E. Other Materials— No modification, changes or other material shall be used with or added to the cement liner material without prior written approval from the manufacturer. Use this product in accordance with the manufacturer’s recommendations for handling, mixing, placing, and finishing.

F. Manufacturer—Standard Cement Materials Inc.; Houston, Texas, 888. 278-1337. www.sales@standardcement.com

3.0 EXECUTION

A. Place covers over the manhole invert while cleaning the manhole’s interior walls. Remove all deleterious materials using a high-pressure washer at 3500-psi minimum. Remove all loose and protruding bricks, mortar, and concrete with a mason’s hammer or scraper. Repair any area that exhibits visible damage, degradation or water seepage.

1. Contractor Responsibilities—the contractor shall bear complete responsibility for mixing of the materials, applying and finishing of the repair system.
2. Mixing—mix the cement with water. No water shall be added at the nozzle.
3. The manufacturer shall provide a source for consultation throughout the application of the cement. Follow the manufacturer’s recommendations for application, sampling, and the testing procedure as described in ASTM C 94 and ASTM C 94M.

B. Spray Application. Dampen the manhole wall surface. Allow some dampness without noticeable free water droplets or running water. Spray the cement liner material to a

uniform thickness. Compact the mortar into all the voids and crevices. Allow the cement material to set 90 minutes.

- C. Place immediately using a shotcrete, gunite, wet-gunned, spin cast or hand trowel application procedure. Apply the cement liner material to a minimum total thickness of 1 inch in one pass. Finish with a steel trowel to a smooth, even surface. Begin at the top; apply the cement mortar down the corbel wall to the invert in such a manner so as to produce a gradual slope from the top of the wall to the invert. Build the bench intersection up and rounded to meet the wall at a uniform thickness no less than ½ inches at the invert and increases in the direction of the wall so as to provide the required slope. Allow the finished cement process to have a minimum of 8-hour cure time before being subjected to active flow. Prevent direct impingement of water up to 24-hour. This product will not affect the set time of the cement.
- D. Contact the manufacturer's recommendation whenever more than 24-hours have elapsed between starting and finishing the application.

4.0 CURING—HOT WEATHER PLACEMENT

- A. Protect the cement mortar; moist cure to avoid potential problems due to shrinkage cracking. Follow ACI 302 and ACI 305 for floor and slab construction, and ACI 308 for Hot Weather Concrete Practice to ensure that problems caused by decreased bleeding are minimized and/ or prevented. Protect the cement from dry, hot wind extremes and severe weather; and freezing. If the ambient temperature is in excess of 90° F then precautions shall be taken to keep the mixing water cool. Use block ice, admixtures or other means to cool the water to a temperature equal to or below 70° F if necessary. Follow the manufacturer's recommendation for trial batches and pretesting of the cement material.
- B. Wet cure immediately, cover with plastic sheets or use an acceptable liquid membrane-forming curing compound per ASTM C 309. The curing compound shall contain a minimum of 25 % solids and prevent a maximum loss of water up to 0.4-kg/m³ in 72 hours. Spray apply the curing compound while the cement is still in a soft workable state.
- C. Protect from freezing up to 24 hours. No application shall be made when ambient temperatures are less than 40°F and freezing temperature is expected within 24-hour

5.0 TESTING AND INSPECTION

- A. Use (3) 2-inch cube molds in accordance with ASTM Test Method C 109, (3) 3-inch diameter by 6 inch cylinders in accordance with ASTM Test Method C 39, or shotcrete panels as in accordance with Practice ASTM C-1140 or as specified by the engineer for testing compressive strength. Make cylinders, cubes, or panels from each day's work and label each with the date, location, and project and product batch numbers. The product batch numbers are located on each cement bag. Send the cylinders, cubes, or panel to a third-party laboratory or the manufacturer for verification. Test the cement sample for compliance with specified strengths at 7 and 28-day periods or in accordance with the engineer's instructions. Retain one sample for further instructions should the others fail to meet the 28-day test requirement. Field samples should not be moved for a minimum of the first 24-hours. Protect and maintain samples in accordance with ASTM sampling procedures.
- B. The engineer shall approve the inspection and quality control procedure before the

project start-up.

C. Quality Assurance—if the manhole does not meet, comply or test successfully with the prescribed standards, the contractor should make corrections and repeat the test procedure until the specifications are met.

D. Manhole Inspection, Verification and Testing

1. At the owner's option, each structure will be visually inspected following the application of the cement liner coating. The Contractor will be required to verify the quality of the applied liner material by using one of the following procedures: (1) a visual inspection which may be recorded in still, digital or video format, (2) vacuum testing in accordance with Test Method C 1244, (3) the water exfiltration method in accordance with Practice C 969, (4) other methods to include an approved third party inspector, a NACE accredited inspector or the manufacturer to check the work for defects, voids or holidays.

6.0 WARRANTY

- A. All of the work shall be guaranteed to be free of defects after the completion of the work. The contractor will repair any defects discovered within the period at no additional cost to the owner. See manufacturers written Warranty Statement.

END OF SECTION

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Standard Cement Materials Inc.
Email: sales@standardcement.com