

Revised: 2011

Repair of Sewer Manholes and Wastewater Structures - Specialty Linings & Coating

Standard Practice for Installing a Protective Cementitious Liner System in Sanitary Sewer Infrastructures

Introduction

In sewer manhole rehabilitation, an ultrafine **MICROSILICA BASED CEMENT** is used for the purpose of restoring structural integrity, stopping water infiltration and to protect against corrosion. The manhole rehabilitation procedure will be accomplished through the application of a monolithic, high strength cement liner. The applications include partial depth repair, full depth restoration, and protection from chemical attack. The corrosion resistant cement shall be used to form a smooth liner coating over the [manholes] interior surfaces; and shall meet or exceed the Federal Highway Administration Department of Transportation Standard HS-20 for traffic loading.

1.0 GENERAL

1.1 SCOPE

- A. The specification shall govern all the labor, materials, and equipment required for the purpose of restoring structural integrity in sewer workings, manholes, pipes, lift station wet wells, water treatment plant structures. The cement is a ready-to-use mortar for new and existing construction repairs and protection against hydrogen sulfide (H₂S) corrosion [and hydraulic abrasion] in sewers. Apply the cohesive, monolithic cement liner to the brick and concrete 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.

1.2 REFERENCES

1.2.1 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-inch Cubes).
- F. ASTM C 267 Test Methods for Chemical Resistance of Mortars, Grouts, and Monolithic Surfacing 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/M Test Method for Splitting Tensile Strength Cylindrical Concrete Specimens.
- K. ASTM C 1140 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 Standard Specification for Packaged, Dry, Hydraulic Cement Grout

1.2.2 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

1.2.3 DEPARTMENT OF TRANSPORTATION STANDARDS

- A. AASHTO T 277 Rapid Determination of the Chloride Permeability of Concrete

1.3 SUBMITTALS

A. Product Data:

1. Technical product data on each product; include brand name and manufacturer
2. Provide laboratory tests results to verify 28-day compressive strength in accordance with the requirements as specified herein.
3. Provide satisfactory test results that confirm conformance to ASTM C 267, Chemical Resistance of Mortars, Grouts and Monolithic Surfacing.
4. Provide a product certification stating the chloride ion content of the cement material.
5. Provide a list of similar sewer manhole rehabilitation projects with a 10-year history. Include the owner's name, contact information, project name and description and date.
6. Provide an independent third party 15-Year Long Term Performance Study of the Microsilica Cement Liner in Aggressive Sewer Manhole Wastewater Environments; CIGMAT; Department of Civil Engineering, University of Houston.
7. Provide the Engineers Design Calculations indicating the repair system meets or exceeds the Federal Highway Administration Department of Transportation Standard HS-20 for traffic loading.

8. Provide independent third party test results confirming chloride resistivity conformance meets or exceeds the Federal Highway Administration Department of Transportation AASHTO T – 277 Standard.

9. Provide a Patent number, franchise, license and or sales agreement for the cement.

B. Contractor Requirements:

1. Provide a manufacturers certification verifying the applicator has been trained [approved] for handling, mixing and inspection of the product(s) to be used, and the application of the system.
2. Five (5) recent references indicating successful application of the cement product(s) within a municipal wastewater environment.
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.

1.3.1 QUALITY CONTROL

- A. Provide a procedure that meets applicable ASTM, NACE and SSPC inspection standards or quality assurance controls that meet the manufacturer's procedure. The engineer will approve the procedure before start up.
- B. The applicator shall follow and enforce quality control procedures consistent with the manufacturer's recommendation.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Keep the products dry and protected from weather, and stored under cover.

2.0 PRODUCTS

2.1 PATCHING MATERIAL

- A. Fast Set Bench™ Mix—a fast setting, calcium aluminate, corrosion resistant cement. Mix the FSR™ Cement [with gloved hand] with cold, potable water for approximately 1-minute. Apply the patching material to repair cracks, fill voids, reform bottoms and create bench sections in manholes. Level the FSR™ Cement 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 >8,000	28-day >10,000
Bond Strength	ASTM C 321	> 140		
Shrinkage	ASTM C 596	0% at 90% RH		
Cement	Sulfate resistant			
Applied Density (28 days)	120 ± 5			

2.2 INFILTRATION CONTROL MATERIAL

- A. Custom Plug Cement—a rapid-setting, hydraulic cement product specifically formulated for stopping water leaks and minor infiltration 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 to a soft putty-like consistency for larger leaks. The CP Cement sets in 60 to 90 seconds. Use it to stop seepage in concrete and masonry structures.

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
Freeze Thaw	ASTM C 666	No loss-100 Cycles		
Sulfate Resistance	ASTM C 267	No Loss		
Volume Change	ASTM C 827	0.0%		

2.3 CEMENT LINER MATERIAL

- A. The Reliner MSP® Cement —is a factory blended, high strength cementitious product. The microsilica cement shall be used as a structural liner material to form a monolithic covering for the manholes interior surface. It contains a blend of highly reactive polymers, finely divided cement and pozzolanic materials, a dry densified microsilica-powder admixture and polypropylene fibers. Apply the Reliner MSP™ Cement liner from ½-inch to 5-inch thickness in one pass.

Physical Property Requirements:

Property	psi			
Compressive Strength	ASTM C 109	24-hr	7-day	28-day
		2,500	4,500	>8,000
Flexural Strength	ASTM C 78			1,000
Split Tensile Strength	ASTM C 496			570
Shrinkage	ASTM C 596		0.0% at 90% RH	
Freeze Thaw	ASTM C 666	No damage -300 cycles		
Bond Strength/ Slant Shear	ASTM C 882			>1,600
Sulfate Resistance	ASTM C 267			No Loss
Chloride Permeability	AASHTO T 277			<300
Applied Density				125 ± 2

1. Microsilica Physical Property Requirements:

Particle Size, maximum	0.15 micrometers
Silicon Dioxide Content, SiO ₂	92-98 %
Dry Bulk Density	9-25 pounds/ ft ³

- B. **NOTE 1**—this dry, powdered admixture produces a dense cementitious liner with improved compressive and flexural strength, high adhesion to damp surfaces, lower permeability and increased resistance to aggressive chemical attack. Its fiber-reinforced formula reduces cracking and improves hydraulic abrasion resistance.
1. Water—Use clean, potable water. No modification or changes should be made to this product or the manufacturer's recommendations for handling, mixing, placing, and finishing of this product.
 2. Other Materials—No other material shall be used with or added to the cement liner materials without prior written approval from the manufacturer.
 3. Manufacturer—Standard Cement Materials Inc; Houston, Texas, 888. 278-1337.
www.sales@standardcement.com
- C. **NOTE 2—Protection for Severely Exposed Sewer Manholes**-Use the 4553™ Epoxy Coating; a 100% solids, self-priming, moisture tolerant epoxy resin for highly corrosive environments, sewerage lift stations, manholes, pipelines and steel surfaces exposed to harsh conditions.

3.0 EXECUTION

3.1 REPAIR PROCEDURE

- A. Place wooden covers over the manhole invert while cleaning the interior walls before applying the cement mortar liner. Use a high-pressure washer at 3500-psi minimum, to remove all deleterious materials from the walls. 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. Mixing:
 - a. Contractor Responsibilities--The contractor shall bear complete responsibility for mixing of the materials, applying and finishing of the repair system. Mix the cement liner material with water. No water shall be added at the nozzle. 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 apply 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 troweled 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 and even surface. Begin at the top. Apply the cement mortar from the top of the corbel down the wall to the invert in such a manner so as to produce a bench having a gradual slope from the bottom of the wall to the invert. Build the walls and bench

intersection up and rounded to a uniform radius from the circumference of the intersection. The thickness of the bench shall be ½ inch at the invert and increase in the direction of the wall so as to provide the required slope. Remove the wooden bench covers. 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 effect the set time of the cement.

- D. Follow the manufacturer's recommendation whenever more than 24-hours have elapsed between starting and finishing the application.

4.0 CURING—HOT WEATHER PLACEMENT

- A. Avoid any potential problems due to shrinkage cracking. Moist cure to avoid potential problems due to shrinkage cracking. Follow ACI 302, 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 to prevent problems due to decreased bleeding. Protect the cement material from dry, hot and severe weather extremes; 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. Follow the manufacturer's recommendation for the use of any admixture. Trail batches and pretesting of the cement material is also recommended.
- B. Protect the cement material. Ambient conditions will govern specific cases. 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. Apply by spray, roller, or brush the curing compound while the cement is still in a soft workable state. Allow the Sewer Manhole Rehabilitation System, to cure approximately 6 to 24 hours.
- 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 test 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 test cubes, cylinders, 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 test cubes, cylinders, or panel to the manufacturer or a third-party laboratory or for verification. The testing laboratory [examiner] shall test the cement samples 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 maintained samples in accordance with ASTM sampling procedures.
- B. The engineer should approve the inspection and quality control 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 for a period of one year after the completion of the work. The contractor at no additional cost to the owner will repair any defects discovered within the 1-year period.

END OF SECTION

© All rights reserved. 1/2011.
Standard Cement Materials Inc.
Houston, TX 77092
email: sales@standardcement.com