

Standard Specification for Installing a Protective Cement Liner System in Sanitary Sewer Manholes to Provide Structural Rehabilitation (As Provided by Standard Cement Materials)

1.0 GENERAL REQUIREMENTS

In sewer manhole rehabilitation, a **MICROSILICA BASED CEMENT** liner system is used for the purpose of restoring structural integrity, stopping water infiltration and providing increased corrosion protection. The manhole rehabilitation procedure will be accomplished through the application of a monolithic, cement liner. These applications include partial depth repair, full depth restoration, and providing corrosion protection from chemical attack. The completed sewer manhole rehabilitation system will be capable of withstanding the Texas Department of Transportation standard for HS-20 loading.

1.01 SCOPE

This specification shall govern all the work, furnishing materials and equipment required for the purpose of restoring structural integrity, eliminating water infiltration and ex-filtration, and providing corrosion protection in sewer manholes and other underground structures. A variety of applications include partial depth repair, full depth restoration, and to provide increased protection from chemical attack and biogenic corrosion. Apply the continuous monolithic structural cement liner to the wall, bench, and other surfaces in the structure.

- A. A certified applicator shall apply the structural cement liner material. All of the cleaning, preparation and application procedures shall be in accordance with the manufacturer's recommendation.
- 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 safety and health practices and to determine the applicability and limitations prior to use.

1.02 REFERENCES

1.02.1 ASTM STANDARDS¹

- C 39 Test Method for Compressive Strength of Cylindrical Concrete Specimens
 - C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. Cubes)
 - C 309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete
 - C 321 Test Method for Bond Strength of Chemical-Resistant Mortars
 - C 882 Test Methods for Bond Strength of Epoxy Coatings Used With Concrete By Slant Shear
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C 49C/ 49M Test Method for Splitting Tensile Strength Cylindrical Concrete Specimens

1.02.2 ACI STANDARDS²

ACI 201.2R-93 Guide for Durable Concrete

ACI 302 Guide for Concrete Floors and Slab Construction

ACI 308 Practice for Curing Concrete

ACI 302 Guide for Concrete Floors and Slab Construction

1.02.3 DEPARTMENT OF TRANSPORTATION STANDARDS³

AASHTO T 277 Rapid Determination of the Chloride Permeability of Concrete

1.03 SUBMITTALS

A. Submit the following information to the engineer:

1. Technical product data, including brand name and manufacturer for each product. Provide laboratory tests results to verify 28-day compressive strength in accordance with ASTM C 39 or C 109.
2. Provide a list of similar sewer manhole rehabilitation projects with a 10-year history. Include the owner's name and the project name, description and date.
3. The manufacturer/ applicator shall furnish all of the labor, equipment and materials to rehabilitate the manhole. The application equipment shall be capable of spraying the cement and epoxy coating materials as required by the manufacturers printed recommendation.
4. Delivery. Store the cement materials under dry conditions at 70°F. No modification should be made to the manufacturer's recommendations for handling, mixing, placing and finishing of this product.

1.03 QUALITY CONTROL

Provide a procedure that meets applicable ASTM, ACI and SSPC inspection standards or quality assurance controls that meet the manufacturers recommended procedure. The engineer will approve the procedure before start up.

1.04 WARRANTY

The applicator shall guarantee the work to be free of defects in materials and workmanship for a one-year period, unless stated otherwise, after completion of the work. The applicator shall repair defects in materials or workmanship, which may

develop during the one-year period; and any damage to other work caused by such defects or discovered within the same period at no additional cost to the owner.

2.0 PRODUCTS

2.01 MATERIALS

A. Use the monolithic cement liner system to repair, fill voids, and provide structural restoration, eliminate water infiltration and ex-filtration and corrosion protection. The applicator shall maintain a strict surface preparation procedure that is suitable and provides the greatest compatibility with the new materials.

B. The following products are approved for use as specified:

1. Fast Set Bench Repair™ Cement—a fast setting, shrink-compensated, corrosion resistant cement product. Hand-mix the FSR™ Cement to patch and repair cracks, fill voids, and reform bottoms, bench areas and invert sections in the sewer manhole. Mix the FSR™ Cement patcher thoroughly for 1 minute; apply with a trowel and smooth uniform and level surface. Keep the patch damp with water or cover with a damp cloth. Protect from freezing, hot temperatures and wind extremes.

a. Physical Property Requirements

Compressive strength		
1-day	ASTM C 109	3500 psi
28-day	ASTM C 109	+ 8000 psi
Bond strength	ASTM C 321	+140 psi
Percent expansion	ASTM C 1107	1.17 %
		0.07 inches
Drying Shrinkage	ASTM C 596	No loss at 90% RH
Density, pcf		117± 5

C. Infiltration Control Material

1. Standard Plug Plus Blue™ Cement—a rapid-setting, hydraulic cement product specifically formulated for stopping water leaks and minor infiltration instantly. The SPB™ Cement sets in 3 to 5 minutes at 77° F. Use it 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. No modification should be made to this product for handling, mixing, placing and finishing.

a. Physical Property Requirements

Compressive strength	ASTM C 109	
1 day		+2000 psi
7 day		+3500 psi
28 day		+4500 psi
Tensile strength	ASTM C 109	
1 day		+ 175 psi

7 day		+ 250 psi
28 day		+ 350 psi
Freeze Thaw Durability		
100 Cycles	ASTM C 666	No Loss
Scaling Resistance		Excellent

2. Standard Plug Plus Red™ Cement—a rapid-setting, hydraulic cement product specifically formulated for stopping water leaks and minor infiltration instantly. The SPR™ Cement sets in 60 to 90 seconds at 77° F. Use it 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. No modification should be made to this product for handling, mixing, placing and finishing.

a. Physical Property Requirements

Compressive strength	ASTM C 109	
1 day		3500 psi
7 day		4900 psi
28 day		5500 psi
Tensile strength	ASTM C 109	
1 day		200 psi
7 day		+ 250 psi
28 day		+ 560 psi
Freeze Thaw Durability		
100 Cycles	ASTM C 666	No Loss
Scaling Resistance		Excellent

3. Chemical Grout—a single-component, non-corrosive, hydrophilic urethane-resin. Mix equal portions with water to form a flexible impermeable foam barrier for stopping the flowing water. Inject this rapid forming grout into the leakage area to form a mechanically bonded compression seal. No modification should be made to the manufacturer's recommendations for handling, mixing, placing, and finishing of this product.

a. Uncured Physical Property Requirements

Appearance	Light Amber Color	
Reaction Time	40 seconds @ 70 ° F	
Solids Content	85%	ASTM D 1259
Viscosity	300-600 cps @ 70 ° F	ASTM D 1638
Flash Point	>25 ° F	ASTM D 93

Cured Physical Property Requirements

Shrinkage	< 2% @ Initial Cure	
Tensile Strength	100-120 psi	ASTM D 3574

Elongation 750-850% ASTM D 3574

4. Cement Liner Material—this section specifies the application of a dense, structural, monolithic cementitious liner used to cover the interior wall substrate surfaces of the sewer manhole. Apply the **Reliner MSP™ Cement** liner from ½ to 5-inch thickness in one pass.

The Reliner MSP™ Cement —is a factory blended, high strength cementitious product. This comprehensive polymer modified cement is a blend of highly reactive, finely divided cement and pozzolanic materials, a dry densified microsilica-powder admixture, polypropylene fibers and other selected admixture ingredients that enhance workability during placement. Contact Standard Cement Materials Inc., Houston Texas for help with selecting a suitable product. The following cement liner product is acceptable.

a. Physical Property Requirements

Compressive Strength		
24 hour	ASTM C 39	2500 psi
28 days:	ASTM C 109	>8000 psi
	ASTM C 1231	8000 psi
Split Tensile Strength	ASTM C 496	570 psi
Flexural Strength	ASTM C 78	1000 psi
	ASTM C 293	>1000 psi
Adhesion to Damp Concrete	ACI 503 R89	Substrate failure
Drying Shrinkage		
90 % Humidity	ASTM C 596	-0.068
Chloride Permeability	AASHTO T 277	280
Water Permeation	ASTM D 1653	< 0.415-grains/ ft ² / hr
Density <small>pounds per cubic foot</small>		118 ± 2

b. 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

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 and provides structural restoration.

5. Manhole Inflow Protector--Supply a corrosion-resistant, 6-gauge No. 304 stainless steel insert. The insert bowl shall allow easy removal from the frame, and meet a load capacity of 3200-psi, minimum.
6. 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.

5. Manufacturer--Standard Cement Materials Inc., Houston, Texas 1. 888. 278-1337 or pre-approved equal. The sewer manhole rehabilitation system must be installed by the manufacturer or a certified applicator or directly employed by the manufacturer.

NOTE 2—Protection for Severely Exposed Sewer Manholes—Use the Standard Epoxy Coating 4553™ for highly corrosive environments, sewerage lift stations, severely exposed manholes, pipelines, steel surfaces and other structures exposed to harsh conditions. The epoxy coating is a 100% solids, self-priming, moisture tolerant blend of Polyamines and Cycloaliphatic Amines and Epoxy Resins.

3.0 EXECUTION

3.01 REPAIR PROCEDURE

- A. Place wooden covers over the manhole invert while cleaning the interior walls. Use a high-pressure washer at 3500-psi minimum, to remove all deleterious materials from the walls and bench sections. Remove all loose and protruding bricks, mortar, and concrete with a mason's hammer or scraper. Repair any invert and bench area that exhibits visible damage or water seepage. Use the FSR™ Cement patcher to repair the damaged area and fill any large voids.
- B. 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.

4.0 CURING

The ambient temperature in the sewer manhole is usually adequate for curing the wet cement liner. However, for the best curing, place wet damp curing blankets, lid, wind shade, an impervious cover or use a high molecular weight curing compound over the cement to protect it from the heat, wind changes or extremes. Keep the lining system clean and dry up to 8 hours.

A. Hot Weather Placement

Avoid any potential problems due to shrinkage cracking. Follow ACI 302, 305, 308 and Hot Weather Concrete Practice to ensure that problems caused by decreased bleeding are minimized. Protect the cement liner from dry, hot, severe weather extremes and freezing. If the ambient temperature is equal to 70°F or in excess of 90°F, then precautions shall be taken to keep the mixing water cool. Use an ASTM C 494, Type A, D, F or G admixture, block ice or other means to cool the water. No application shall be made when ambient temperatures are less than 40°F and freezing temperature is expected within 24-hour. 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, roll, or brush the curing compound while the cement is still in a soft workable state. This lining method can be stopped and restarted as job conditions allow. All washed out areas should be allowed to cure 24 hours, cleaned, and spayed again. The Sewer Manhole Rehabilitation System, the SLS System©, is acceptable for day, nighttime or continuous 24-hour work schedules.

5.0 TESTING AND INSPECTION SECTION

A. SAMPLING

1. Use test cylinders per ASTM C-39, or as specified by the manufacturer for testing compressive strength. Make three test cylinders from each day's work. Label the cylinders with the date, location, project name and product batch numbers on each one. The product batch numbers are located on each cement bag. Send the cylinders to a third party laboratory or the manufacturer for verification. Test in accordance with Test Method C-1140. Test the cement material for 7 and 28-day periods. Retain one sample for further instructions should the others fail to meet the 28-day test requirement.

B. Inspection

1. The inspector or the manufacturer's representative will be required to visually inspect each structure following the application of the cement liner and epoxy coating system. Acceptable test methods include visual inspection, or vacuum testing, or digital photos/videos. If vacuum testing, testing may begin 48 hours after the manhole has been rehabilitated, or as specified by the manufacturer. Any areas determined to have inadequate coverage in the finished coating, and defects, voids or holidays shall be repaired. Upon final completion of the work, the manufacturer will provide a written certification to the Engineer. The certification will confirm that the repair materials were applied according to the manufacturer's recommendations.

6.0 Basis of Payment

A. Payment shall be based on the Contract Unit Price as indicated in the Rehabilitation Section Schedule. The Contract Unit Price shall be payment in full for performing the work and for furnishing all labor, supervision, materials, equipment and all the testing necessary to complete the work.

END OF SECTION

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