

Specialty Coatings: Repair of Corrugated Metal Culverts

Standard Practice for Installing a Protective Cementitious Coating for Corrugated Metal Culverts

Introduction

A singular, ultrafine **POLYMER MODIFIED MICROSILICA CEMENT** coating is used to protect concrete pipe and corrugated metal culverts (CMP) from corrosion and abrasion and meet design service life requirements. The cement coating is proposed for covering (360°) of the interior surface of the pipe. The coating is designed to provide a corrosion barrier, sealing of the existing surface, structural reinforcement and abrasion resistance of the existing pipe, existing concrete storm sewer pipe, corrugated metal pipe culvert, and concrete sanitary sewer pipe.

1.0 GENERAL

1. The specification shall govern all the labor, materials, and equipment required for the purpose of covering the entire periphery of the pipe, depth of the pipe, size and diameter, groundwater pressure and the existing conditions of the CMP culvert pipe.
2. The cement coating over the interior surface shall meet, reach or exceed the Federal Highway Administration Department of Transportation Standard HS-20 for traffic loading.
3. 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 REFERENCES

- | | |
|-----------------|--|
| 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
- N. ACI 201.2R-93 Guide for Durable Concrete
- O. ACI 302 Guidelines for Concrete Floors and Slab Construction
- P. ACI 308 Practice for Curing Concrete
- Q. ACI 302 Guidelines for Concrete Floors and Slab Construction
- U. AASHTO T 277 Rapid Determination of the Chloride Permeability of Concrete

1.2 SUBMITTALS

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 an independent third party 15-Year Long Term Performance Study of the Cement Liner in Aggressive Sewer Wastewater Environments; CIGMAT; Department of Civil Engineering, University of Houston.
6. Provide independent third party test results confirming chloride resistivity conformance meets or exceeds the Federal Highway Administration Department of Transportation AASHTO T – 277 Standard.
7. Provide a Patent number, franchise, license and or sales agreement for the cement.
8. Contractor Requirements:
 - a. Provide a manufacturers certification verifying the applicator has been trained for handling, mixing and inspection of the product, and application of the cement.
 - b. Five (5) recent references indicating successful application of the cement product(s) within a municipal wastewater environment.

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

9. 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.
- b. The applicator shall follow and enforce quality control procedures consistent with the manufacturer’s recommendation.

10. Delivery, Storage, And Handling

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

2.0 PRODUCTS

2.1 Invert Repair Material

- 1. Maximum CA™ Cement
- 2. The dry packaged, sprayable Maximum CA™ Cement is applied at low pressure to produce a high strength, protective coating for both new and existing concrete and CMP metal pipe inverts. The fiber reinforced cement provides toughness and corrosion resistance, and provides abrasion resistance in concrete pipes and sanitary works. Additionally, gun applied the cement as a protective coating to the invert surface from 1 to 3 inch thicknesses.

3. Physical Property Requirements:

Property	psi			
Compressive Strength	ASTM C 109	24-hr 3,500	7-day >9,000	28-day >9,000
Bond Strength	ASTM C 882	>2,400		
Tensile Strength	ASTM C 190	>1,700		
Shrinkage	ASTM C 596	0% at 90% RH		
Chloride Permeability	AASHTO T 277	<300		
Applied Density (28 days)				135
Cement	Sulfate resistant			

2.1 Cement Liner Material

- 1. Reliner MSP® Cement is a single-component, polymer modified Portland cement mortar for horizontal, vertical and overhead surfaces, concrete and brick sewer working, corrugated

metal culvert pipes, concrete sanitary pipes and storm water drainage infrastructure rehabilitation. The comprehensive, cement offers the additional benefit of Geopolymer binders to produce calcium - silicate rich paste that provides increased adhesion and workability during placement, corrosion protection and abrasion resistance.

- a. Water—Use clean, potable water.
 - b. No modification or changes should be made to this product or the manufacturer's recommendations for handling, mixing, placing, and finishing of this product.
 - c. Other Materials—No other material shall be used with or added to the cement liner materials without prior written approval from the manufacturer.
2. Apply the Reliner MSP™ Cement liner from ½-inch to 5-inch thickness in one pass.
 3. Physical Property Requirements:

Property	psi			
Compressive Strength	ASTM C 109	24-hr	7-day	28-day
		3,500	4,500	>9,000
Flexural Strength	ASTM C 78	>1,000		
Tensile Strength	ASTM C 496	570		
Split Tensile Strength	ASTM C 882	>2,675		
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	2000 ppm (sulfuric acid)		Good
		20000 ppm (sulfuric acid)		Slight scaling
Chloride Permeability	AASHTO T 277	<300		
Applied Density	125 ± 2			

4. Microsilica Physical Property Requirements:

- Particle Size, maximum 0.15 micrometers
- Silicon Dioxide Content, SiO₂ 92-98 %
- Dry Bulk Density 9-25 pounds/ ft³

- a. **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.

3.0 EXECUTION

1. Substrate Preparation: begin with high-pressure water blasting the entire substrate. Use a water washer with rotary tip at 3500-psi minimum, to remove all deleterious materials from the pipe invert, wall, and ceiling. Thoroughly inspection of all the suspect areas over the interior surface and spot repair any area that exhibits visible damage. Next plug and patch all

voids and cracks with Custom Plug Cement to stop active water intrusion around cracks and in voids or distressed areas and water seepage.

2. Remove all loose cement mortar and concrete in the pipe. The cement mortar is applied by hand, using a trowel to work material into suspect areas, providing a uniform.
3. Spin Cast Application. Position the Spin Cast applicator in the center of the sewer pipe invert, CMP culvert and or concrete pipe. Locate and make final adjustments to the spin head elevation in the culvert to distribute the cement mortar coating material uniformly, from the center of the structure. Apply 185 cfm air pressure to the 1500 Spin Head motor and [listen] visually verify the delivery head is turning. Begin pumping the cement mortar to the spin head. The cement mortar coating material shall be a uniform thickness as it is applied by the spin casting applicator. The structural cement mortar application is designed to reinforce the existing CMP culvert pipe; the existing culvert will serve as the form for the new coating material. Retract the Spin Caster sled at a steady slow pace to achieve an even application of the cement mortar coating and repeat layering to the desired thickness. Maintain a steady retrieval at a consistent speed towards the rear of the pipe.
4. Place immediately using a spin cast application method. Apply the cement liner material to a minimum total thickness of (1) one to (3) three inches over the highest point [top of the pipe groove] of the pipe corrugation in one pass. Leave a semi-smooth surface. Begin at the far end and apply the cement mortar evenly along the wall and over the invert, and ceiling.
5. 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.
6. Follow the manufacturer's recommendation whenever more than 24-hours have elapsed between starting and finishing the application.

4.0 CURING—HOT WEATHER PLACEMENT

1. Moist cure to avoid any 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, 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.
2. Protect the cement material. Ambient conditions will govern specific cases. Wet cure immediately, cover the pipe ends with plastic sheets and 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 or roll the curing compound while the cement is still in a soft workable state.

3. 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 IINSPECTION

1. 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 maintain samples in accordance with ASTM sampling procedures.
2. Visual Inspection, Verification and Testing

At the owner's option, each structure will be visually inspected following the application of the cement coating. The Contractor will be required to verify the quality of the applied cement material by using one of the following procedures: (1) a visual inspection which may be recorded in still, digital or video format, (2) other methods to include an approved third party inspector, or the manufacturer to check the work for defects, voids or holidays.

END OF SECTION

© All rights reserved. 1/2013.
Standard Cement Materials Inc.
Email: sales@standardcement.com