Evaluating Spectrashield Coating for Concrete Manhole: Hydro-Static PressureTest

SPECTRASHIELD
Coating Materials

(Wet Concrete Coating)

Report

by

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CONTENTS Page No.

LIST OF FIGURES

SPECTRASHIELD COATING FOR CONCRETE MANHOLE

1. Introduction

Concrete manholes are used to access and also to allow aeration of drain or sewer systems conveying sewage or surface water under gravity. Concrete is one of the most commonly used construction material in sewage manholes. During rainy season, the hydrostatic pressure on the concrete manhole due to raising water table could increase and the manhole should be strong enough to withhold such high water pressure. Coatings are used to rehabilitate manholes and other infrastructures and hence will be subjected to the external hydrostatic pressure. Hence the performance of the coatings must be evaluated using full-scale pressure tests. The bonding strength between concrete and coating must be high enough to prevent water infiltration into the manhole. So bonding between the concrete surface and the coating material is another important property that must be evaluated to determine the performance of the coating.

ASCE document on Manhole Inspection and Rehabilitation (Hughes, 2009) identifies several methods for repairing manholes such as coating, lining the surface of manholes and chemical grouting. The document recommends a minimum thickness of coating of at least 0.05 inch. For coatings and liners the document recommends the following ASTM standards for surface preparation:

i. ASTM D 4258 for surface cleaning concrete for coating
ii. ASTM D 4259 for surface preparation of abrading concrete.

This document also summarizes a couple of more guidance (SSPC SP-13 & ICRI 03732) for the performance and inspection of concrete surface preparation. For polymer coating thickness

measurement, it recommends ASTM D 4414 which specifies standard practice for measurement of wet film thickness by Notch gauges. It also recommends ASTM D 4787 test method for continuity verification of sheet linings applied to concrete substrates.

EPA document summarizes various products used for manhole rehabilitation (Sterling et al., 2009). However in this report no test method has been recommended to evaluate the performance of the products used.

WEF manual discusses about coating systems and structural linings used for rehabilitation of manholes (Oman, 2000). It recommends ASTM C 267 test which deals with standard methods for chemical resistance of mortars, grouts and monolithic surfacing and polymer concretes. However this manual did not mention any test method for testing the performance of coating under hydrostatic pressure.

2. Objectives

The objective of this experimental study are as follows:

1) Evaluate the performance of Spectrashield coating applied to a leaking concrete manhole by loading up to a hydrostatic pressure of 50 psi and unloading.

3. Material and Method

A 4 feet diameter and 3 feet high concrete manhole was used for this study (Fig 1 & 2). The manhole had a joint in the middle which was leaking. The coating material consists of three parts as shown in Figure 3.

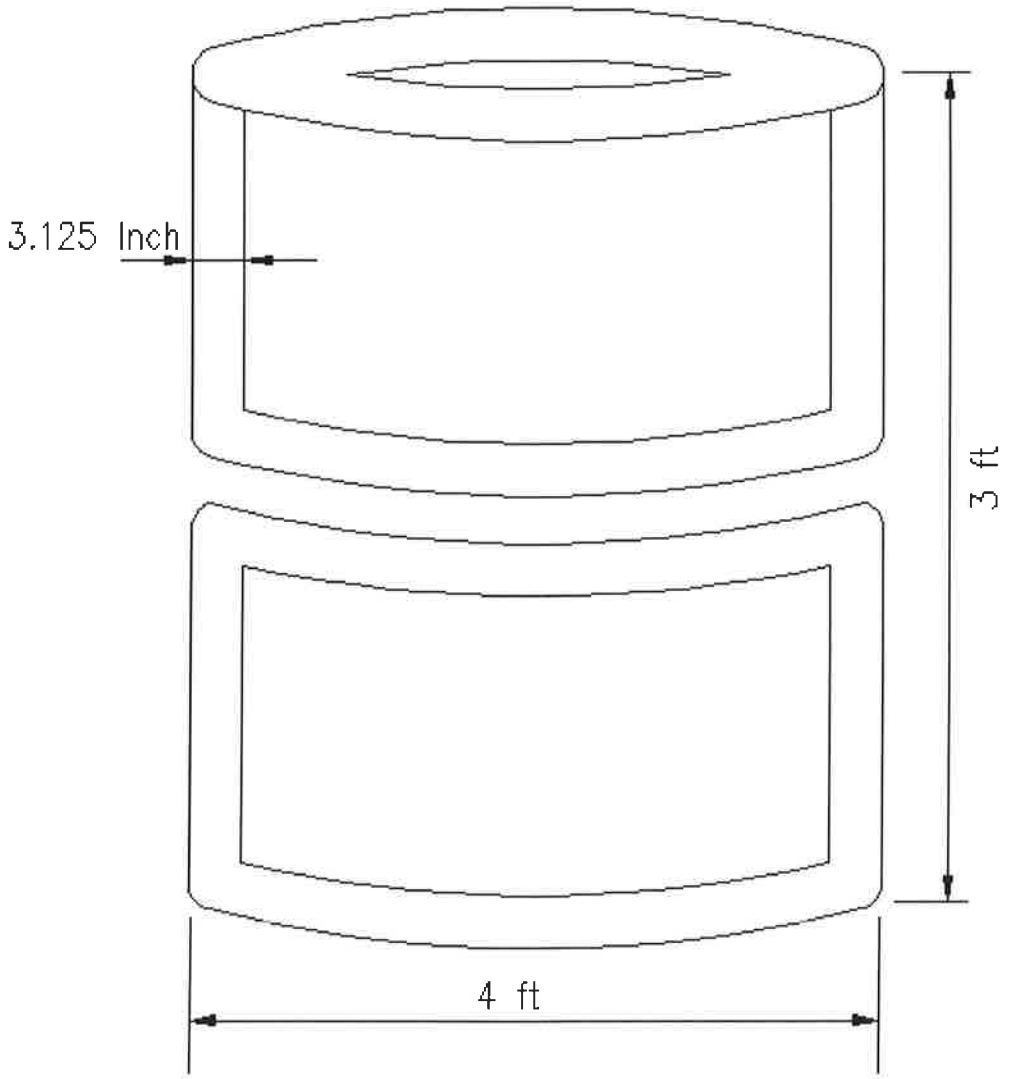
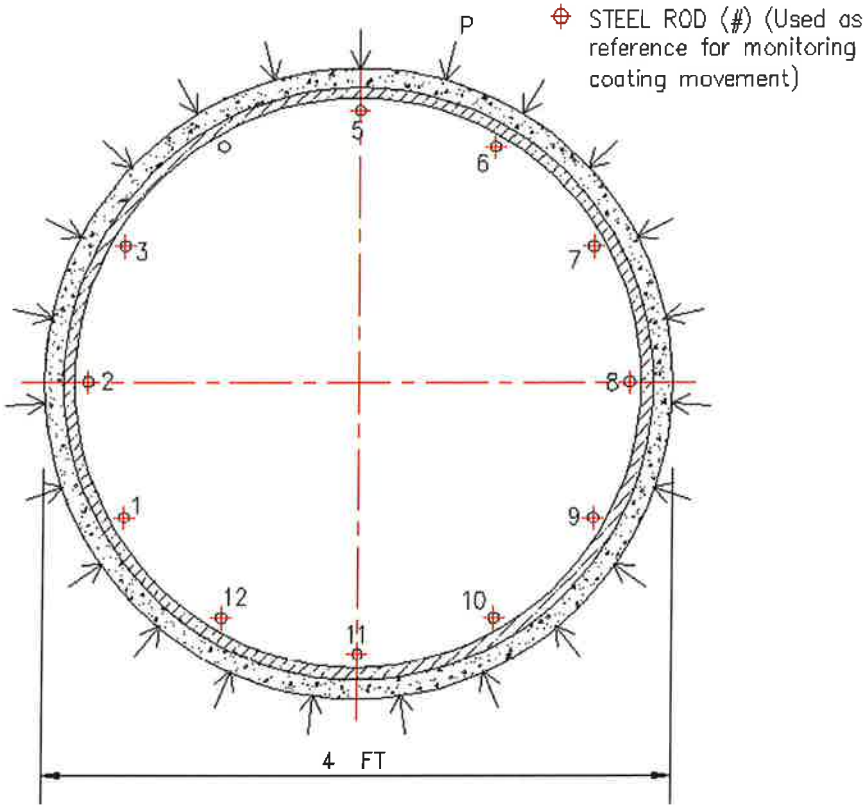


Figure 1. Schematic of the concrete manhole

(a) Elevation



(b) Plan

Figure 2. Test Chamber

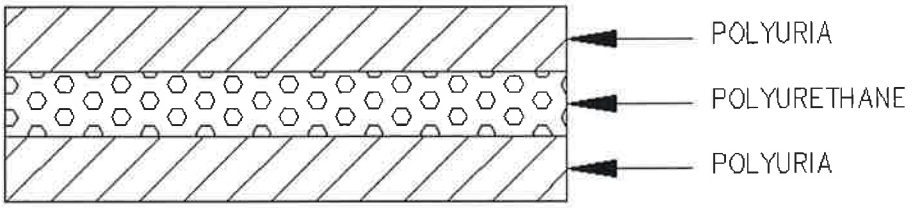


Figure 3. Cross section of the three layer coating

3.1.Full-Scale Test

The coating was applied to a wet concrete surface. Wet coating condition simulated a manhole in service.

a) Saturation of manhole

The concrete manhole was submerged into a water tank (Fig 4) for 7 days before applying the coating.

Figure 4. Saturation of manhole

b) Wet coating

The concrete surface was water blasted before coating with Spectrashield coating. The coating was done by the coating manufacturer.

c) Pressure test

The coated concrete manhole was placed in a specially designed test chamber for testing manholes (Fig 2). The hydrostatic pressure was applied from outside the manhole in incremental steps to the coated concrete manhole. The coating was inspected for leaks and the distance between the steel rod and coating were measured to an accuracy of 0.001".

The hydrostatic pressure history used to test the manhole is shown in Fig.5. The pressure was initially increased in steps 5 psi up to 50 psi and then reduced. The total test period was 41 days.

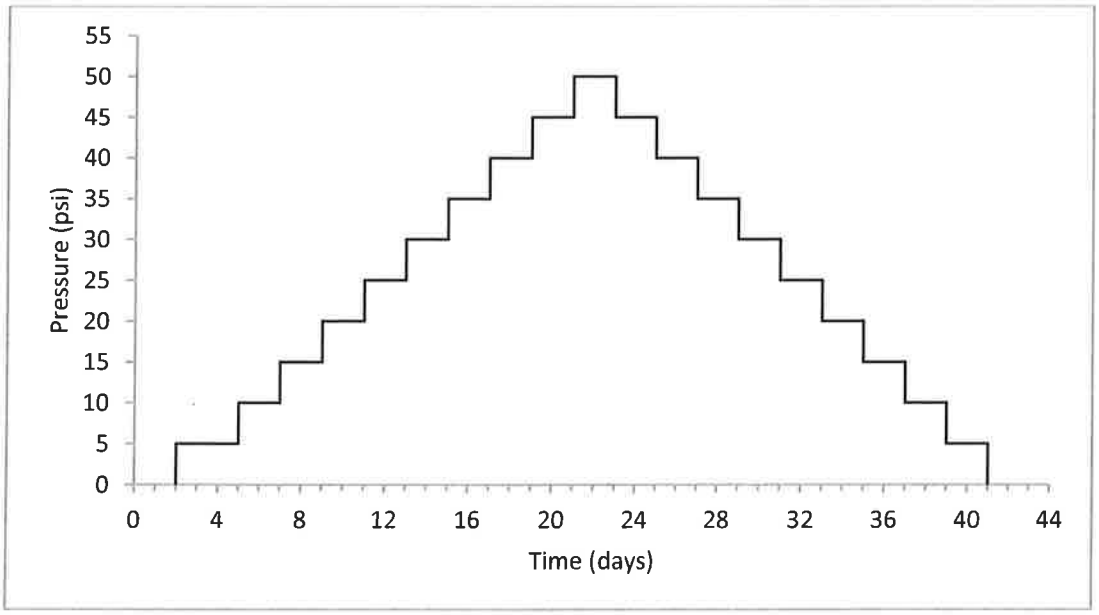


Figure 5. Applied hydrostatic pressure versus time

Visual Inspection: Deformation of coating at each hydrostatic pressure and leakages on the coated concrete surface were visually monitored and inspected regularly.

d) Test procedure

1. The concrete manhole was placed in a steel testing chamber. Water swelling agent was applied on the bottom and top ring of the concrete manhole to avoid leakage of water from the ends.
2. The outside chamber was filled with water.
3. Initial readings of coating with respect to the steel rods were taken using a vernier caliper.
4. The hydrostatic pressure was increased from 0 to 5 psi on the 2^{nd} day.
5. On the 5^{th} day the coating distances from the steel rods were taken and then the pressure was increased to 10 psi on same day since the concrete manhole coating was stable at 5 psi.
6. On the 7^{th} day the coating distances from the steel rods were taken and then pressure was increased to 15 psi.
7. The next coating distances from the rods were taken on 9^{th} day and then pressure was increased to 20 psi. The concrete manhole coating remained stable.
8. Step 7 was repeated till 23^{rd} test day for every two consecutive days with increment of a pressure of 5psi up to 50 psi.
9. On the 23^{rd} day, the coating distances were taken under a pressure of 50 psi and the pressure was reduced to 45 psi on same day.
10. On the 25^{th} day, the coating distances from the steel rods were taken and then pressure was increased to 40 psi.
11. Step 10 was repeated up to 41^{st} days by reducing the pressure by 5psi (every two days) up to 0 psi.

(a) View of the coating measurement **(b) Vernier caliper for deformation**

Figure 6. Coating at hydrostatic pressure of 30 psi

4. TEST RESULTS AND DISCUSSIONS

This study was performed in the CIGMAT laboratory at the University of Houston.

4. 1. Coating Materials

(a) Full-Scale Test

In order to evaluate the potential of applying the coating SPECTRASHIELD coating, manhole with wet surface (simulating in service condition) and water leaks was used. Performance of coating was evaluated for a period of six weeks.

Application

The coating was applied successfully under wet conditions in the CIGMAT laboratory. Coating was applied with ease. Coating was inspected during and immediately after application. No immediate defects (blistering, cracking, discoloration, spalling, sticking to the finger after 48 hours of application) were observed on the coated surfaces.

Performance

The coating was tested under a hydrostatic pressure of up to 50 psi over a period of six weeks. For monitoring purposes the coating movement was measured in reference to the twelve steel rods. The coating was inspected on a regular basis to identify any visible defects and the same was mapped as shown in figures in Appendices A and B. In Appendix A, movement of the coating at each depth behind the rod is plotted. In Appendix B, movement of the coating behind each rod with applied pressure is plotted. Each section was evaluated for (i) Overall condition (ii) Amount of water leakages (iii) Movement of coating and (iv) Change in color.

Based on the testing for a period of 41 days, following observations are advanced:

(i) Overall condition of the coating was good

(ii) No water leak through the coating

(iii) Movement of the coating was observed with increase in pressure, (Figs A1 through A48 and B1 through B12).

(iv) No color change

5. Conclusion

Based on the full-scale pressure test following observations are advanced:

1. The average coating movement at hydrostatic pressure of 50 psi was 0.119 inch.
2. Reducing the hydrostatic pressure resulted in recovery of the coating to it's near original shape.
3. The movement of the coating was uneven with depth and was influenced by the applied pressure.
4. Minimum deformation of coating was 0.001 inches at 2ft at steel rod #3.

5. Maximum deformation of coating was 0.3 inches at 2 ft at steel rod #7.
6. Overall average deformation at depth of 3 ft from the bottom was 0.021 inches.
7. Overall average deformation at depth of 2.5 ft from the bottom was 0.022 inches.
8. Overall average deformation at depth of 2 ft from the bottom was 0.056 inches.
9. Overall average deformation at depth of 1.5 ft from the bottom was 0.026 inches.
10. Overall average deformation at depth of 1 ft from the bottom was 0.028 inches.
11. Overall average deformation at depth of 0.5 ft from the bottom was 0.018 inches.

6. References

1. Hughes J.B., (2009). "Manhole rehabilitation and Inspection" *Manhole rehabilitation of the pipeline division of the American Society of Civil Engineers, ASCE Manuals and Reports on Engineering Practice No.92, Edition 2.*
2. Sterling R., Wang L., and Morrison R., (2009). "White Paper on Rehabilitation of Wastewater Collection and Water Distribution Systems" *U.S. Environmental Protection Agency, EPA/600/R-09/04, Cincinnati, Ohio.*
3. Oman P., (2000). "Epoxy issues in manhole rehabilitation projects" *Water Engineering and Management-Vol. 147, Issue 4*, 28-30.

Appendix A

Coating Movement versus Applied Pressure Relationship