Standard Specification

Sydney WATER

SS 211
Corrosion Protection of Sewers Using Magnesium Hydroxide Coating

1. General

1.1. Objective

To set requirements for application of corrosion protection for concrete and masonry sewers using magnesium hydroxide based coating.

1.2. Scope

The work covered by this document includes the followings:

1. Product
2. Surface preparation
3. Application of protective coating

1.3. Roles and Responsibilities

This document is written in directive style. Where an obligation is stated, it is meant to be undertaken by the Contractor. Where a submission, request or proposal is required and it is not stated who the recipient shall be, it is to be provided to Sydney Water (the Principal) for approval.

Responsibilities relating to the contractual terms and conditions, including financial matters, health and safety, and site issues are covered in the Contract document. Specific responsibilities are noted in this document, but they do necessarily describe all the activities required for the work.

1.4. Definitions

Term	Definitions
Acid Neutralisation Resistance (ANC)	The level of an alkaline material to react and neutralise a certain amount of acid(s)
Coat	A continuous layer of a material resulting from a single application.
Coverage efficiency	The ratio of practical coverage over theoretical coverage
Practical coverage (m^2/L)	The actual amount of surface area (in m^2) that is covered by a litre of coating material for a specified thickness. The consumption shall include application losses.
Solid content	The amount dry solids as a percentage of wet mass of a slurry
Theoretical coverage (m^2/L)	The maximum amount of surface area (in m^2) that can be covered by a litre of coating for a specified thickness
Wash-off resistance	The resistance of a coating material to partial or complete wash-out inside a concrete or masonry sewer pipe
Wet film thickness	The thickness of the coating immediately after application

1.5. References

Document No.	Title
AS 1289.4.3.1 – 1997	Methods of testing soils for engineering purposes - Soil chemical tests - Determination of the pH value of a soil - Electrometric method

Document No.	Title
AS 4489.9.1 – 1997	Test methods for limes and limestones - Solid content - Convection oven
AS/NZS 1580.107.3 – 1997	Paints and related materials - Methods of test - - Determination of wet film thickness by gauge
ASTM D7377-09(2013)	Standard Practice for Evaluating the Water Wash-Off Resistance of Traffic Paints using a Water Faucet
CEN/TS 14429:2005	Characterization Of Waste - Leaching Behaviour Tests - Influence Of pH On Leaching With Initial Acid/base Addition
CEN/TS 14997:2007	Characterization of Waste - Leaching Behaviour Tests - Influence of pH on Leaching With Continuous pH-control

2. Quality Control and Warranty

2.1. Supplier Supervision

A representative from the product supplier (the Supplier) shall witness the application of the product during the initial period and other time(s) deemed required. The Supplier shall ensure and be satisfied that the product has been applied in accordance with the Supplier's specification. The Supplier shall also provide adequate technical support relating to the product when required.

2.2. Approved Applicator

The surface preparation and application of protective coating shall only be carried out by an applicator (the Applicator) that has been approved by the Principal.

2.3. Warranty

The finished product shall be free of defects that may affect the ongoing operation and maintenance of the sewer. They include defects arising from the use of non-complying materials, substandard equipment, inadequate surface preparation and poor application workmanship.

Furthermore, the followings are considered as defects and non-performances:

- Inadequate coating thickness at time of application
- Excessive variation in thickness at time of application
- Reduction of the coating pH level to less than pH 7 within 12 months of application
- Disappearance of coating in areas above the highest flow level within 12 months of application

The Applicator may be instructed to remove, repair or replace defective work and non-performing product at no cost to the Principal.

3. Product

Materials and equipment used for this work shall be in accordance with the requirements specified herein along with the Supplier's specification. If there is a disagreement between those, a direction from the Principal shall be sought.

The product shall be a proprietary product specially designed to withstand corrosive sewer environment. Alternative product(s) with equivalent or better performance characteristics may be used, subject to prior approval from the Principal.

For products consisting of two more parts e.g. Part A and Part B, which require mixing on-site prior to application, the Supplier shall specify the appropriate mix ratio and method.

3.1. Material Composition

The $Mg(OH)_2$ content of the protective coating shall be determined using an Inductively coupled plasma atomic emission spectroscopy (ICP-AES) calibrated using a solution of Magnesium of known concentration.

The minimum content of $Mg(OH)_2$ shall not be less than 53%.

3.2. Solid Content

The dry solid content as a percentage of the wet coating slurry shall be determined in accordance with the test method described in AS 4489.9.1-1997.

The solid content shall be between 53% and 61%.

3.3. Acid Neutralisation Resistance (ANC)

The inhibitive property of magnesium hydroxide based protective coating material arising from its ability to neutralise the acid(s) in sewers. This may be characterised by its acid neutralisation capacity.

The minimum ANC of the coating shall be 18.9 milimoles of acid per gram sample (mM H^+/g), when determined in accordance the test method described in Appendix A.

4. Surface Preparation

Surface preparation comprises all work prior to application of protective coating. It includes surface cleaning, inspection of cleaned surfaces and if required, a repeat of the surface cleaning activities. The aim of the surface preparation is to remove all loose and foreign materials that may hamper performance of the applied protective coating.

4.1. Cleaning

Foreign materials and loose concrete and mortar joints deteriorated by corrosion shall be removed using high-pressure water cleaning method at a pressure between 5,000 and 10,000 psi with a water flow rate between 5 and 50 L/min. The water used shall be of a quality that does not contaminate the surface.

The distance of the cleaning nozzle should be no greater than 600 mm from the surface. Closer distance should be used when removing persistent adherent foreign materials and corroded concrete, or where the sewer has not been treated with Magnesium Hydroxide coating in the last 5 years.

For non-man entry application, the cleaning equipment shall be designed to suit the size and shape of the sewer. Where concrete has suffered significant corrosion and contains large aggregates (5 mm or greater), the non-man entry cleaning shall be carried out using multiple nozzles having opposing angles to minimise shadowing effect. Otherwise, a multiple pass cleaning from opposing directions shall be carried out.

4.2. Post Cleaning Inspection

4.2.1 Visual Inspection

All cleaned surfaces shall be inspected using Closed Circuit Television (CCTV) or visually, to ensure quality of cleaning.

Any major infiltration, defective joint, deteriorated inlet or outlet or exposed reinforcement found following surface preparation shall be reported to the Principal for further direction.

4.2.2 Surface pH level

The surface pH of the 'freshly' cleaned concrete shall be spot-checked using universal pH indicator spray at two measurement locations. The first location shall be within three (3) metres downstream and the second location shall be within three (3) metres upstream of every maintenance hole. Three (3) pH readings shall be taken at every location. The readings shall be taken at 9, 12 and 3 o'clock positions inside the pipe.

The cleaning shall be repeated until the pH is 7.0 or greater.

The Principal may nominate other testing locations. The use of phenolphthalein or phenol red solution in lieu of universal pH is acceptable.

5. Coating Application

Only product(s) approved by the Principal shall be used. The material shall be applied strictly in accordance with the Supplier's specification.

The surface prior to coating application shall be clean and sound. The surface preparation method shall be in accordance with requirements detailed in the previous section, unless otherwise approved. The application is to proceed as soon as practicable after cleaning to minimise surface contamination.

5.1. Application

The coating shall be applied using spray method. For non-man entry application, the spray equipment shall be designed to suit the size and shape of the sewer. The distance of the spray nozzle from the surface should be no greater than 600 mm.

Where concrete has suffered significant corrosion and contains large aggregates (20 mm or greater), the application shall be carried out using multiple nozzles with opposing angles to minimise shadowing effect.

Unless otherwise approved, a minimum of two (2) passes shall be carried out. The applied coating shall have a nominal thickness of 1.5 mm.

5.2. Post Coating Application Inspection

5.2.1 Visual Inspection

All coated surfaces shall be inspected using CCTV or visually, to ensure that all concrete surfaces are adequately covered by the coating. The applied coating shall be uniform, free of lumps, wavy, sags and runs.

5.2.3 Coating Thickness

The applied coating's average film thicknesses shall be calculated by using the following formula:

$$Average\ thickness = \frac{Volume\ of\ coating\ used}{Coated\ area}\ x\ Coverage\ efficiency$$

The coated area shall be calculated by multiplying the length of coating application with the coated perimeter, which is typically the internal sewer area above the Peak Dry Weather Flow (PDWF) level. The average thickness calculation shall be reported. The average thickness shall be equal or greater than the nominal thickness of 1.5 mm.

The average thickness shall also be verified by carrying out spot measurements using wet film thickness gauge in accordance with AS/NZS 1580.107.3:1997 at two measurement locations. The first location shall be within three (3) metres downstream and the second location shall be within three (3) metres upstream of every maintenance hole. Six (6) thickness readings shall be taken at every location. The readings shall be taken at 9, 10, 11, 12, 1, 2 and 3 o'clock positions inside the pipe. No spot measurement shall be less than 1 mm.

6. Performance Monitoring

At 12 months following the coating application and any other times nominated by the Principal, the performance of the applied coating shall be assessed.

The assessment shall include CCTV or visual inspection, and measurement of the residual pH level of the coating using the method described in AS 1289.4.3.1-1997.

The performance of the applied coating shall be deemed to be unsatisfactory or no longer effective, if there is:

- a reduction of the coating pH level to less than pH 7; or
- a disappearance of the coating in areas above the highest flow level, typically Peak Wet Weather Flow (PWWF).

Appendix A Acid Neutralisation Capacity (ANC) Test Method

The inhibitive property of alkaline protective coating materials arising from its ability to neutralise the acid(s) produced by microbiological activities in sewers may be characterised by its acid neutralisation capacity. This involves plotting the steady state pH against the quantity of acid added to a series of ground samples to obtain a titration curve. The method is adopted from European Committee's CEN/TS 14429 and CEN/TS 14997.

Each test consists of adding 1 g of wet sample to 10 ml of acidic solution to maintain a solid:liquid ratio of 1:10. The acidic solution is prepared by adding a predetermined quantity of 70% nitric acid to deionised water to generate a range of pH from 4 – 12. The solutions are kept at 28-30°C and shaken at 350 rpm in sealed containers; until the pH of the solution reaches a steady state (variation in pH is within ±0.3 pH unit). The pH of the solution shall be measured using a pH meter that had been calibrated using standard buffer solutions.

The ANC results shall be reported in milimoles of acid per gram wet sample (mM H+/g).

Document control

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Change History

Version	Date	Description of change	Approved by
1	31/7/14	New document	PG
2	23/9/14	Coating thickness and testing locations, material composition and solid content, removal of wash off resistance criterion, number of application pass	PG