WATER SERVICES ASSOCIATION OF AUSTRALIA

THE UNIVERSITY OF SYDNEY

Sewer Corrosion Classification - Gas Phase

What causes corrosion in sewers?

Concrete, protective coatings and other materials are subject to corrosion when exposed to chemical conditions such as those found in sewers. Corrosion in the gas phase of sewer assets is attributed primarily to the attack by micro-organisms and their acidic metabolic products (e.g., H_2SO_4). This is also referred to as micro-biologically induced concrete corrosion (MICC).

How do we rate corrosion?

Corrosivity is a term used to refer to the severity of corrosion. Its impact can be measured from the loss of functionality of the concrete such as loss of alkalinity, material and strength (see Figure 1).

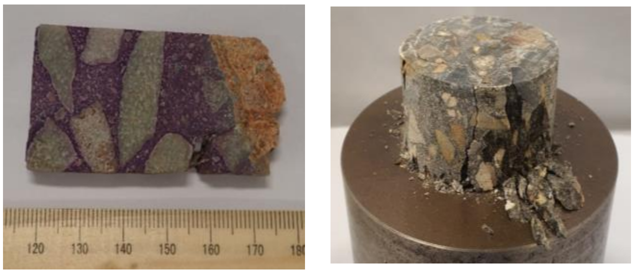


Figure 1. Concrete specimen showing partial corrosion (left) and strength testing of concrete (right)

Why is corrosion classification important for asset management?

Information on the corrosivity of an environment is a basic requirement for the selection of material for construction, selection of mitigation strategies (e.g. type of protective coating), estimation of service life and life cycle cost of the material. Currently, only one classification is used for sewer corrosivity where it is designated as a "severe environment".

Objective of this work

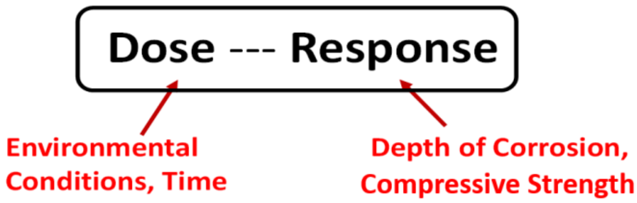
This work was developed to provide guidelines for quantitatively classifying the corrosivity of sewer environmental conditions in the gas phase in terms of their effect on corrosion of concrete assets. Specifically, large diameter pipes and related infrastructure such as access chambers and wet wells.

Application

This classification can be used by designers and water utility practitioners to assist with decisions including: pipe or asset rehabilitation prioritisation, selection of appropriate protective concrete-based coatings for repair, selection of materials for use in construction and for the planning and design of future concrete assets.

Approach

This classification of sewer corrosion was established, based on a '*dose-response*' method.



The 'dose' refers to the sewer environmental conditions and the 'response' is the measure of corrosion. The classification was established by comparing the impact of sewer environmental conditions on the corrosion performance of existing reinforced and unreinforced ordinary Portland concrete assets. Cement based protective coatings, specifically calcium aluminate and geopolymer coatings, were installed and monitored over time. These trials were carried out in large diameter pipes (DN2000+) and access chambers in Sydney Water, Melbourne Water, SA Water, Water Corporation and Urban Utilities.

Environmental monitoring - 'dose'

Environmental conditions on their own do not measure corrosion but they can provide surrogate measures, or indirect measures, of sewer corrosivity. Specific conditions are required to grow and promote the actions of MICC. These key parameters are:

- Hydrogen sulfide (H_2S)
- Carbon dioxide (CO_2)
- Relative Humidity
- Temperature

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To establish the corrosivity of a sewer environment, continuous monitoring for at least two weeks must be carried out (see test method 2B.3). The 90th percentile results must be used to provide statistical estimates of the gas compositions and conditions from the overall survey.

Corrosion performance – 'response'

Corrosion performance of each material was established by taking core samples of the un-lined assets and applied coatings. Testing the core samples constitutes a semi-destructive test used to evaluate the corrosion resistance of the different cementitious material. The extent of corrosion can be established from the core by determining:

- Depth of corrosion (see test method 2B.1)
- Residual unconfined compressive strength (AS 1012.9)

Predictive Models – Sewer Asset Failure

Predictive failure models of the sewer assets provide a way of capturing the 'dose-response' to corrosivity. The models predict the depth of corrosion and residual compressive strength of the concrete asset as a function of service life and environmental conditions (see fact sheet: Sewer Rehabilitation & Prioritisation Decision Platform).

Classifying Environmental Conditions

The environmental parameters were divided into corrosion categories according to their impact. The categories are based on ISO standards. ISO standards define categories based on their corrosion impact (C1: very low; C2: low level; C3 medium; C4: high and C5: very high). Table 1 provides a general corrosion classification of sewer environments. The failure predictive models should be used for more accurate prediction of corrosion impact (see fact sheet: Sewer Rehabilitation & Prioritisation Decision Platform).

Table 1. Sewer Corrosion Classification

Environmental Conditions				Predicted Depth of Corrosion (mm)		Corrosion Impact	Corrosion Classification
H_2S (ppm)	CO_2 (ppm)	T_g(°C)	RH (%)	10 years of service	100 years of service		
>155	<2500	15-30	95-99	>30	>180	Very High	C5
135-155	2500-4400	15-30	95-99	21-30	166-180	High	C4
70-135	4400-7600	15-30	95-99	14-21	120-166	Medium	C3
15-70	7600-9400	15-30	95-99	6.7-14	55-120	Low	C2
0-15	>9400	15-30	95-99	<6.7	<55	Very Low	C1

The Sewer Corrosion Classification was developed by the University of Sydney.

Contact:
Professor Marjorie Valix
School of Chemical and Biomolecular Engineering
The University of Sydney, NSW 2006
E: marjorie.valix@sydney.edu.au

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