BACTERIOGENICALLY INDUCED SULFURIC ACID ATTACK ON CONCRETE IN AN AUSTRIAN SEWER SYSTEM

Grengg, C.[1], Mittermayr, F.[1,2], Baldermann, A.[1], Böttcher, M. E.[3], Leis, A.[4] & Dietzel, M.[2]

[1]Institute of Applied Geosciences, Graz University of Technology, Rechbauerstraße 12, 8010 Graz, Austria
[2]Institute of Technology and Testing of Building Materials, Graz University of Technology, Inffeldgasse 24, 8010 Graz, Austria
[3] Leibniz Institute for Baltic Sea Research (IOW), Seestraße 15, D-18119 Warnemünde, Germany
[4]RESOURCES – Institute for Water, Energy and Sustainability, Joanneum Research, Elisabethstraße 18/2, 8010 Graz, Austria
e-mail: cyrill.grengg@gmx.at

This study provides insights in the processes that cause severe concrete corrosion and deterioration of an Austrian sewage system, which urgently requires restoration.
Various crucial parameters for detecting alteration features were determined in the field and laboratory, including temperature, alkalinity, pH, and conductivity measurements as well as ion-chromatography, inductively coupled plasma optical emission spectrometry and X-ray diffraction analyses. Furthermore, the concentration of gaseous H_2S, CH_4 and CO_2 within the sewer pipe atmosphere was measured. Dissolved sulfate content of the damaged concrete and the corresponding aqueous solutions were obtained, by precipitation as barium sulfate.
The deterioration of the sewage system is attributed to a couple of complex processes, which are referred to as bacteriogenically induced sulfuric acid attack. Anaerobic bacteria, present within the sewage systems, have consumed the organic matter quantitatively, thereby reducing SO_4^{2-} to $H_2S_{(g)}$. Changes in the surrounding air pressure or water convection within the sewage chamber subsequently promoted degassing of the H_2S, followed by its oxidation into elemental sulfur or other sulfur containing phases by the aerobic bacteria Acidithiobacilli. This led to the formation of sulfuric acid that reacted with the CH-phases of the concrete to form gypsum (SCRIVER & DE BELIE, 2013), which finally caused the severe damage of the concrete.
Within the most heavily damaged concrete the SO_4 concentrations were calculated to be 14-27 wt. %, which correlate well with abundant gypsum. In contrast, the SO_4 concentration of the aqueous solutions was surprisingly low, ranging between 13 and 41 ppm. The pH of the sewage water fluctuated between 6 and 8 as well as the $H_2S_{(g)}$ concentrations, which were from below the detection limit up to >100 ppm. The $CO_{2(g)}$ concentration ranged between 400 and 2500 ppm, while the CH_4 concentration remained below the detection limit.
Further investigations, including sulfur isotope measurements, are planned, which may give new insights into the complexity of bacterially controlled reaction paths that finally cause the concrete damage in sewer systems.

SCRIVER, K., DE BELIE, N. (2013): In: BERTON, A., DE BELIE, N., ALEXANDER M. (eds): Performance of Cement-Based Materials in Aggressive Aqueous Environments, 305-318, Springer, Ghent.