T2 - Corrosion of concrete by sulphuric acid in sewers and performance tests

Doctoral students: Maria Sielaff

Supervisors: Prof. Dr. Dietmar Stephan, Prof. Dr. Matthias Barjenbruch, Regina Gnirß

Introduction

The enlargement of the sewer system, longer sewers and decreasing amounts of sewage in occupied areas lead to increasing detention times of sewage in the sewer system. In consequence more biogenic sulphuric acid is produced causing corrosion of sewer pipes, shafts and other parts of the sewer system. Many different laboratory tests have been developed to ensure the use of concrete with a higher lifetime in acidic environments. The different laboratory tests are barely compared among another or with the corrosion in real sewers.

Aims

This project aims for a deeper understanding of corrosion mechanisms and sulphate-containing components on the interface between water, sewer atmosphere, and building material. Therefore concrete specimens are exposed to sewer atmosphere in the research pilot plant of Berliner Wasserbetriebe (BWB) in Berlin-Neukölln and analysed.

The second aim of this project is to gain knowledge about the applicability of laboratory performance tests on sewer systems and their time lapse effect. The specimens of the same concrete or mortar compositions are tested in four laboratory performance tests. The results of the analysis are being compared between the laboratory performance tests and the results from the research pilot plant of BWB. Therefore it will be possible to evaluate the performance tests regarding their comparability and their applicability to sewer systems.

Methods

For the tests in the research pilot plant of BWB and the laboratory performance tests five concrete or alternatively mortar compositions were chosen (chosen sample names are OPC, White, CEM III a, CEM III b, and SRB 85/35). They differ regarding their binder composition and water binder ratio and therefore show different behaviour in contact with sulphuric acid.

In January 2017 twelve specimens of each concrete composition were put the sample chambers of the research pilot plant. The concrete will be sampled biannually.

The performance of the concrete or mortar is tested at TU Berlin after the methods of MPA Berlin-Brandenburg [1,2], LPI [3], E DIN 19573 appendix B [4] and at Universiteit Ghent after the TAP test [5].The abrasion of all samples is measured with reflected light microscopy of polished samples. The corrosion zones of the all the samples are analysed by polarising microscopy of thin sections. Selected samples are additionally analysed scanning electron microscopy and micro X-ray fluorescence. Due to the

method’s setup the roughness and change in diameter of the samples from the TAP method are measured by a laser setup.

Results

The test after MPA Berlin Brandenburg and the TAP test have been completed. The measured roughness and change in diameter show that the concrete types White and CEM III a performed best and SRB 85/35 performed worst during the TAP test. The average damage depth of the samples from MPA Berlin-Brandenburg test were measured from the abrasion and corrosion zones. Figure 1 shows an example for the analysis by polarising light microscopy and highlights the corrosion zones.

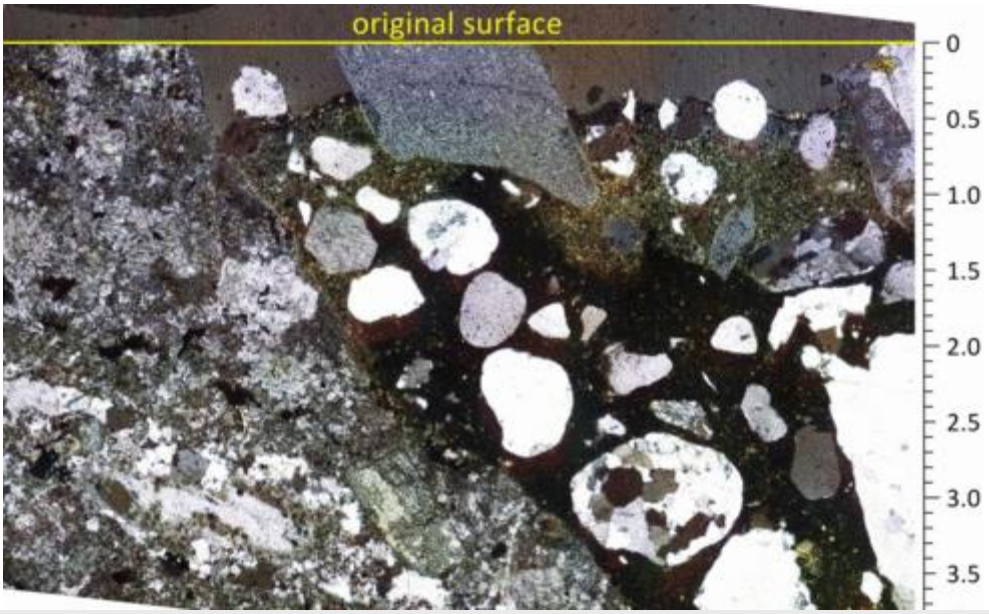

Fig. 1: Thin section of Ordinary Portland Cement (OPC) concrete after12 weeks in sulphuric acid at pH = 3.5 and weekly brushing (MPA Berlin-Brandenburg test). The photo was taken at a polarizing light microscope with crossed polarisers (enlarge to see animation).

The abrasion depth and the average damage depth is higher for brushed samples and increases from the test duration of 6 weeks to the testing duration of 12 weeks. The zone of massive gypsum formation is independent of the brushing. The concrete types SRB 85/35 and White perform best and OPC and CEM III a perform worst during MPA Berlin-Brandenburg test. A comparison of the results from TAP test and test after MPA Berlin-Brandenburg is illustrated in figure 2. The different performance of SRB 85/35 in both tests might be caused by the strongly differing boundary conditions of the tests (e.g. pH-value of the sulphuric acid, different ratio of concrete surface to acid volume).

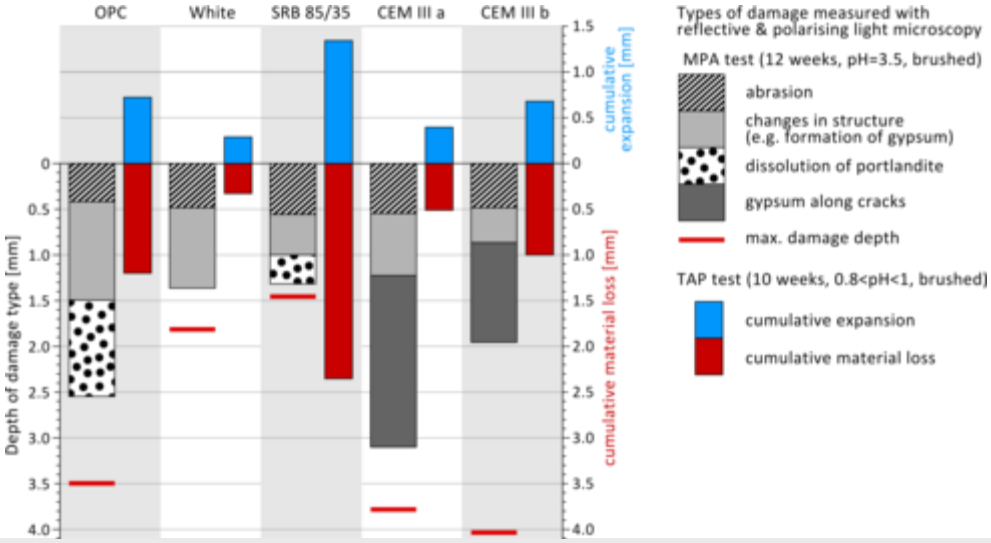

Fig. 2: Comparison of the results from the test after MPA Berlin-Brandenburg and the TAP test.

Collaborations

- Other UWI projects: T3 (Katharina Teuber)
- Kollegiate: Daneish Despot
- Common topic: Interfaces in sewer systems
- Berliner Wasserbetriebe, Kiwa Berlin, Universiteit Gent

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