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MICRO-CT ANALYSIS APPLIED TO LIME MORTARS FOR DAMAGE ASSESSMENT DUE TO ACCELERATED WEATHERING

Introduction

Weathering of construction materials is one of the main causes for building deterioration and failure. Amongst some of the most important factors contributing to this outcome is the presence of salts in the system and their crystallization/dissolution behavior during ageing. These salts occupy the space within the pore network of the materials and manifests itself only once some damage has already been caused. It is of outmost importance to develop efficient methods for testing, evaluating and development of damage prediction of this phenomena to obtain better and more durable materials.

Methodology

For the non-destructive damage assessment, high resolution X-ray micro-computer tomography will be used as a non-traditional characterization technique before and after weathering [Fig. 1]. Weathering by salt damage tests were performed under similar experimental conditions to assess the impact of water and the length of temperature and relative humidity samples on the durability of the mortars.

Research questions

- Can lime-based mortars show any representative damage due to salt damage?
- Is it possible to assess and quantify damage caused by salt crystallization and weathering inside the porous media in a non-destructive manner?
- Can a lab-based protocol imitate real life weathering damage without destroying the samples?

Experimental conditions

Six lime-cement mortars were tested for NaCl weathering by comparing two different contamination and propagation of damage regimes. These regimes consist of cycles of temperature and relative humidity variations followed by rewetting steps with water.

Test 1 [Fig. 2]

5% NaCl + 3 cycles + rewetting with 100% initial water

Test 2 [Fig. 3]

5% NaCl + 4 cycles + rewetting with 30% initial water

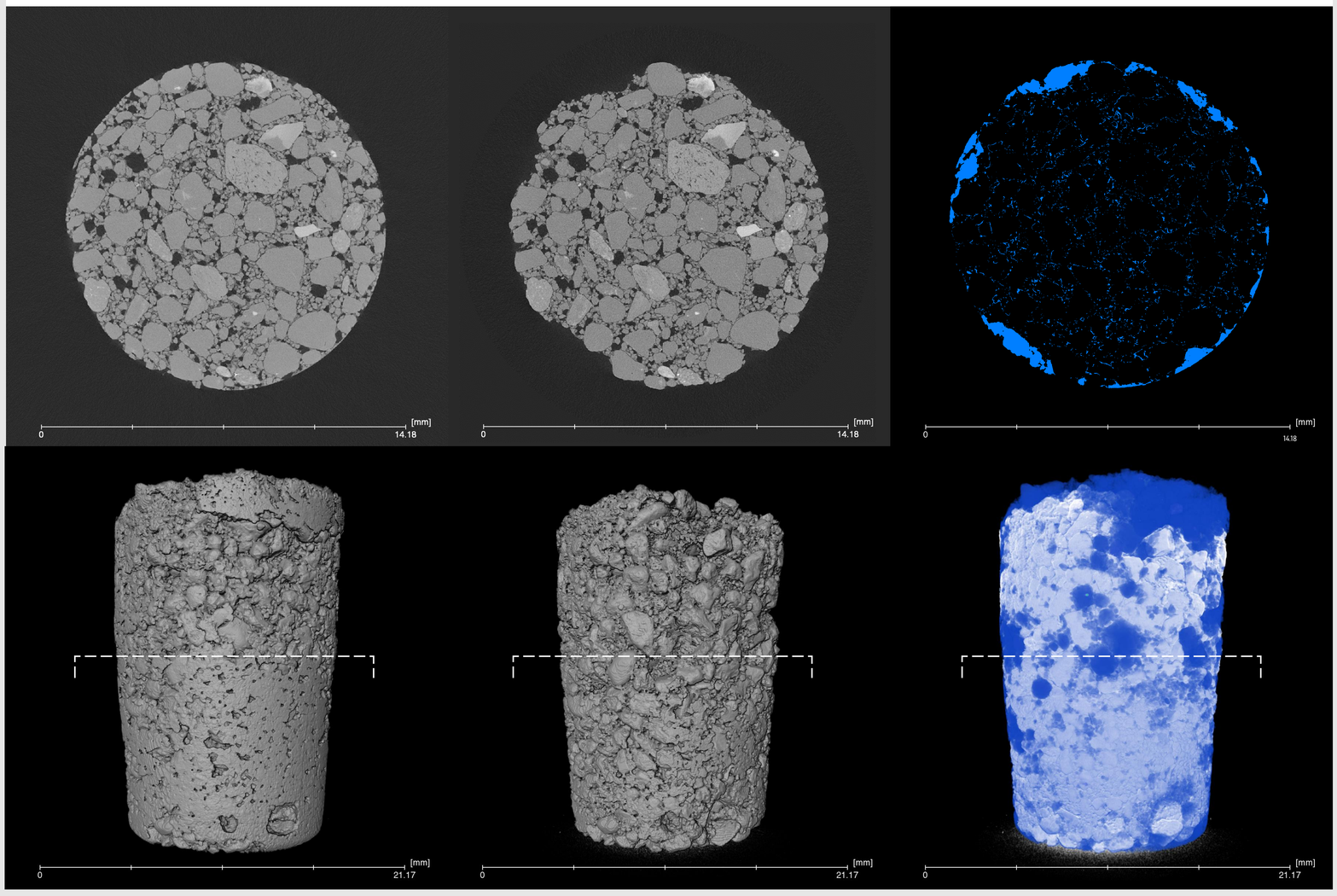

Figure 1. Micro-CT scans of a 1:0:3 mortar cylinder (12 µ resolution) before and after accelerated ageing of Test 1 and total material loss of 10.39 % of the initial volume.

Results

The micro-CT scans taken before and after weathering were subtracted, and the resulting volume corresponded to the total volume loss during the cycles (10.38%) [Fig. 1].

The amount of water used for the rewetting steps was a critical factor on the weathering cycles. Test 1 had a more aggressive effect than Test 2 on the samples' surface [Fig. 4], and also resulted on higher mass fluctuations and debris due to the salts crystallization pressures in less amount of time [Fig. 5].

Conclusion

Micro-CT scans proved to be a very valuable technique to characterize damage on porous materials. Besides allowing for a volumetric quantification of the damage, it locates the damage for a better understanding of the processes in the interior of the materials without destroying the specimens.

This experimental weathering protocol yielded optimistic results for the future development of reliable standards for durability assessment on mortars.

Accelerated weathering

There are currently some protocols and recommendations to test materials' performance towards salt crystallization. Nevertheless, these are mainly focused on rocks, bricks and masonry units, aiming towards failure. This research intends to propose a more suitable protocol for mortars that allows for the characterization of the salt crystallization and its products in a more reliable and quantifiable manner, based on the RILEM TC ASC-271 recommendations.

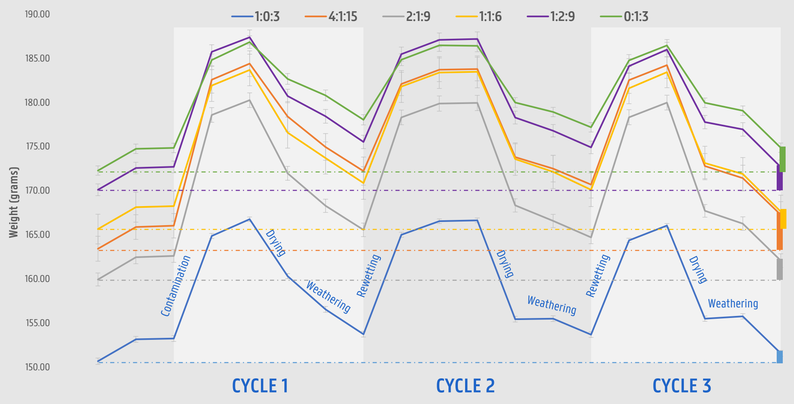

Figure 2. Test 1 photographic documentation and weight monitoring results expressed in grams. Significant mass gains are observed by the end of the 3rd cycle (Fig. 5).

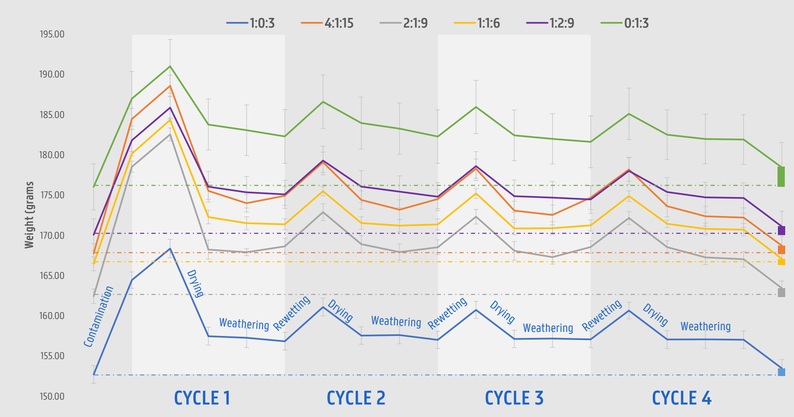

Figure 3. Test 2 photographic documentation and weight monitoring results expressed in grams. Lower mass fluctuations and final mass gains are observed by the end of the 4th cycle (Fig. 5).

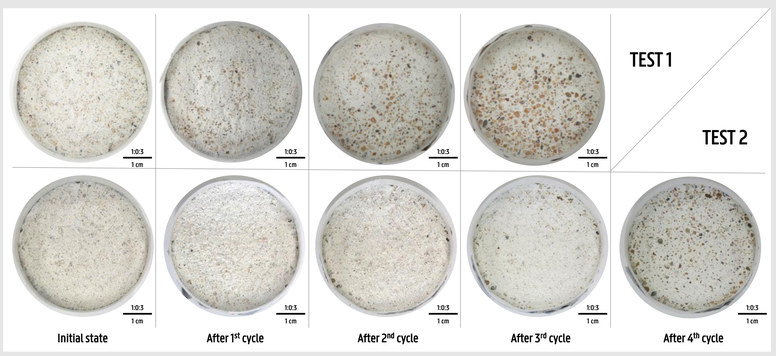

Figure 4. 1:0:3 sample surface after every weathering cycle of Tests 1 and 2.

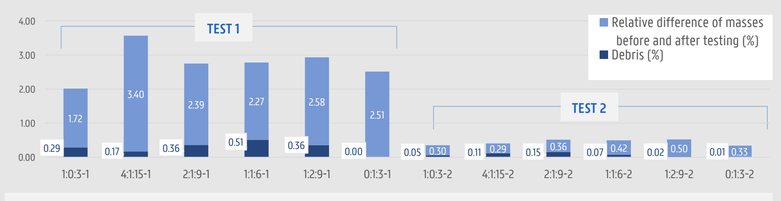

Figure 5. Final relative mass differences obtained before and after weathering (light blue), including final mass of total resulting debris (dark blue).

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