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X-RAY MICRO-COMPUTED TOMOGRAPHY TO STUDY SALT PRECIPITATION AND SALT DAMAGE IN MULTILAYERED POROUS MATERIALS

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1. Introduction

Over the last years, many studies have been conducted in order to investigate salt crystallization damage in simple building materials [1]– [2], but only a few have been devoted to studying this mechanism when it comes to multilayered material [3]. The JPI-CH project CRYSTINART combines experimental and numerical research in order to investigate salt crystallization damage in multilayered materials and the role of the interfaces between these layers. Within this project, X-ray micro-computed tomography (µCT) is employed to analyze structural changes, such as pore filling and crack formation, during salt crystallization, in two types of layered porous media: antique Dutch tiles, and consolidated glass beads with a hydrophobic-hydrophilic interface.

2. Materials and Methods

Antique Dutch tiles (i.e multilayered artworks with a glaze layer and a clay body) were first characterized for their structural, hygric and mechanical properties using several technics (X-ray µCT, XRD, MIP, among others). Then, tile samples with an intact and with a crazed glaze were exposed to a salt weathering protocol of wetting-drying cycles with NaCl and Na_2SO_4 during which X-ray-CT scans were made intermittently. Qualitative and quantitative image analysis using the software Dragonfly (ORS) allowed evaluating the evolution of salt accumulation and damage. A second study was conducted using a 3D artificial porous medium of consolidated glass beads. The idea was to mimic a multilayered porous material, to that extent a hydrophobic layer was created in the artificial porous medium to impose a sharp interface between a hydrophobic and a hydrophilic zone. Work is currently ongoing to study the salt crystallization process, occurring during drying of an initially wet sample, by means of in-situ X-ray µCT.

3. Results and Conclusion

During the weathering tests on the tiles, weight monitoring showed salt accumulation inside their structure, which was confirmed by the X-ray µCT data analysis. For the contamination with sodium sulfate, salt accumulation was manifesting by salt clusters during the initial cycles and occurred only close to the interface between the clay body and the glaze layer. In further cycles, cracks occurred in the sample with an intact glaze, and they were located in the interface between the salt clusters and the rest of the porous structure, whereas the sample with a crazed glaze only showed salt accumulation without damage. For the contamination with sodium chloride, the tested samples showed salt accumulation through clusters distributed all over the clay body. In this case, further cycles did not cause any damage to the samples. These results represent valuable input as well as validation data for the numerical model predicting salt damage that is being developed within the CRYSTINART project.

4. Acknowledgements

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5. References

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