Salt crystallization in substitution renders for historical constructions

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Abstract In Portugal, rehabilitation and conservation interventions are assumed of increasing relevance. Renders are used as decorative and protective coats, acting as sacrificial layers, particularly exposed to climatic actions and mechanical and environmental impact, becoming the most vulnerable constituents of historical buildings. Incompatible repair render solutions are still being specified, nowadays, for old buildings, not taking into account the specific situation, the background and the pre-existing materials. Salt damage is one of the major causes of renders decay, not only near the sea but also in continental areas. One of the most abundant and common salts present in walls is sodium chloride. The crystal growth is usually induced by changes in ambient temperature or relative humidity. These salts can appear in the walls from different sources: from the ground due to rising damp, carried by the wind as salt spray, flooding or originally present in materials, like unwashed beach sand or due to the salt transport behaviour of the substrate/render and the surrounding ambience severity (temperature and relative humidity) producing salt crystallization. In this paper an experimental laboratory campaign was developed with perforated red bricks rendered on both sides with four different render compositions and different permeability, submitted to capillary absorption in a sodium chloride solution. Particular attention is given to the influence of different renders solutions when contaminated with NaCl and along the several dissolution-crystalization cycles: (a) in the location of sodium chloride crystallization in the specimens; (b) crystallization quantification of different specimens. The final goal is to understand the relation between the more or less permeable renders and NaCl dissolution-crystallization cycles damage mechanisms, in order propose possible solutions to stop or slow down the salt decay process in walls contaminated with this salt and subjected to changes in ambient temperature and relative humidity.

1 Conclusions

The present experimental work demonstrates that the accelerated dissolution/crystallization cycles with sodium chloride, favour the accumulation of NaCl salt on the render or/and on the top of the brick, as efflorescences.

Different specimens show different crystallization accumulation patterns.

The study of crystallization and damage localization and evolution is crucial for their understanding in brick masonry.

The main conclusions that can be drawn from this experimental work are:

- The specimens specially designed for this experimental work were able to simulate brick masonry with internal plaster and external render, in laboratory.
- With the adopted testing methodology, we could understand the main differences on crystallization considering the whole system (brick masonry + render more or less permeable).
- The visual evaluation of specimens' surface crystallization (Table 3) and the crystallization quantification (Fig. 7) give consistent results.

- Relevant differences can be found in final salt distributions between specimens with cement based render (less permeable) and only with lime based (permeable) render. For the last ones, there is a similar distribution of salts on renders surface and on top of the brick and for less permeable specimens there is a higher salt concentration on the top of the brick when compared to render's surface.
- The specimens with high heterogeneity between internal plaster and external render show the highest damage, namely those rendered on one single side, and those with a lime render (L or LMet) on one side and CRes on the other.
- In specimens with low permeability render CRes, it was found the highest crystallization on the brick, especially on CRes-CRes specimens. Apparently CRes render acts as a barrier, restricting the evaporation of the water through render and allowing higher crystallization on the top of the brick, where the evaporation occurs. This behaviour indicates a tendency of cement renders of low permeability to favour crystallization in the masonry, increasing damage inside the wall.
- The specimens with high and/or medium permeability renders L-L, LMet-LMet, L-C and LMet-C, concentrate crystallization on the render, preventing high damage in the brick. These results point out to the conclusion that the referred types of systems are to be preferred in conservation of old walls, considering that the objective is to increase the durability of the masonry, and not so much the renders's durability.

Based on the main conclusions, investigations must be carried on with SEM on the surface and cross sections of the specimens, at the end of the weathering tests, to better understand the deposition of the salts in depth and the influence of render formulations on salt crystallization and possible decay.
It is also important to study the porous structure of the bricks and of the mortars applied, and to compare them, in order to establish a link with the degree and localization of salt damage.

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2 References

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