2nd International Conference on Moisture in Buildings (ICMB23), online, 3-4 July 2023

A Study of The Impact of Acrylic Based Surface Waterproofing on The Moisture Behaviour of Brick Masonry Through Dynamic Vapour Sorption (DVS) And Water Absorption Tests

Henry Zhu[a,b*], Yasemin D Aktas[a,b], Dina D'Ayala[a]

a Department of Civil Environmental and Geomatic Engineering (CEGE),UCL, London, UK
b UK Centre for Moisture in Buildings (UKCMB), London, UK

Abstract

The rate and extent of uptake and release of moisture and liquid water are critical in understanding the behaviour of masonry materials. This study focussed on testing brick masonry to identify the moisture performance difference after treated with acrylic based surface waterproofing – commonly used to lessen water uptake and improve façade durability. Brick and mortar specimens were first tested for water absorption then treated and retested 0, 12 and 24 months later to evaluate the short- and long-term impact of waterproofing on their water absorption capacity. Dynamic Vapour Sorption (DVS) tests were also conducted to quantity the change in their (de)sorptive characteristics. Results from both tests were combined to show the impact and durability of acrylic waterproofing on the moisture behaviour of brick masonry.

Peer-review under the responsibility of the organizing committee of the ICMB23.

Keywords: waterproofing, water repellence, surface treatment, brick masonry, mortar, water absorption, dynamic vapour sorption (DVS)

1. Introduction/Background

Moisture damage in buildings can lead to structural damage, mould growth, freeze-thaw and health problems for occupants (Aktas et al., 2017). Surface waterproofing treatments are a way to prevent moisture damage by creating a water-repellent barrier on the exterior surfaces of buildings (Aktas et al., 2021). They can be applied to new or existing buildings, and silicone-based coatings are a common type known for their durability and resistance to UV rays (Sahoo et al., 2011). Dynamic Vapor Sorption (DVS) as a method for measuring the moisture sorption properties of materials, is important in studying the rate and extent of moisture uptake and release in materials and understanding the mechanisms that control it (Maclean et al., 2021). A combination study utilizing both DVS and water absorption test can contribute to the understanding of the impact of surface waterproofing treatments on the moisture behaviour of brick masonry.

2. Test Design and Procedure

2.1. Absorption test: Following EN ISO 15148:2002, three different types of specimens were used: 100 x 100 x 100 mm mortar cubes, 215 x 102.5 x 65 mm standard dimension full bricks, 215 x 140 x 28 mm masonry specimens made with brick and mortar. The measurement of weight was taken at 5min, 20min, 1h, 2h, 4h, 6h, 8h, 10h and 24h. The second test was tested 12 months later with the same specimens and the third test was tested 24 months later with test duration expanded to 72h.

2.2. DVS test: Following BS EN ISO 12571:2021's chamber method, specimens on both surface and interior of bricks and mortar were prepared to investigate the representativity of brick masonry. Three specimens of each type were first tested untreated then treated and tested again after 7 days. The DVS analyser generates the sorption and desorption of water vapour of a specimen through the mass change at 20°C with RH steps from 0% to 95% with 10% interval each step and 95% as final step, then back to 0% with the same interval.

3. Test results and conclusions

Figure 1 summarise the results of three sets of absorption tests on brick and mortar specimens, carried out two weeks after treatment ("0") and repeated after 12 and 24 months ("12" and "24"). Masonry specimens were tested at 12, 24 and 36 months after treatment. In the first test, untreated bricks and masonry specimens reached saturation in about 2h, while mortar specimens took about 4h. However, both the treated and untreated brick specimens showed a faster absorption rate than mortar, while the masonry specimens demonstrated comparable weight gains to the bricks. In the 12 months test, the saturation time has increased to 4h for the untreated bricks and 2h on masonry specimens, with minor delays on mortar specimens. Further, the extent and rate of absorption significantly dropped for mortar and masonry specimens compared to 0-month, while for

* Corresponding author. +44 7928547646, henry.zhu@ucl.ac.uk

 DOI: 10.14293/ICMB230056

brick they increased. In the 24 months test, test duration was expanded to 72h to further examine the behaviour of materials. The weight change of untreated specimens also continues to decrease, especially on masonry specimens.

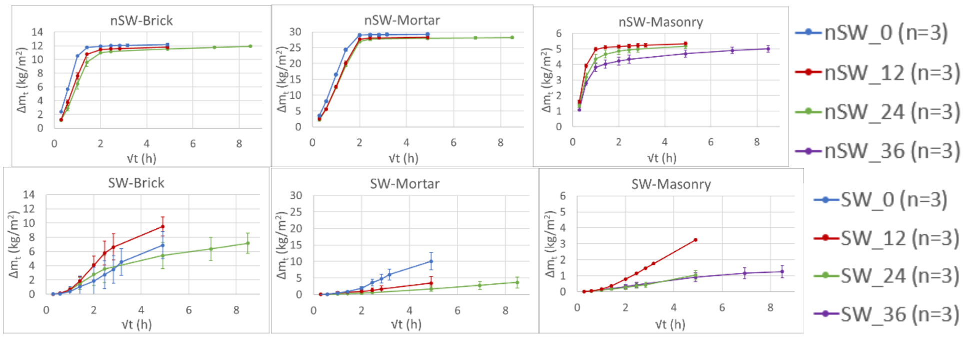

Figure 1: Weight gain of brick and mortar specimens (top row non-surface waterproofed, bottom row surface waterproofed)

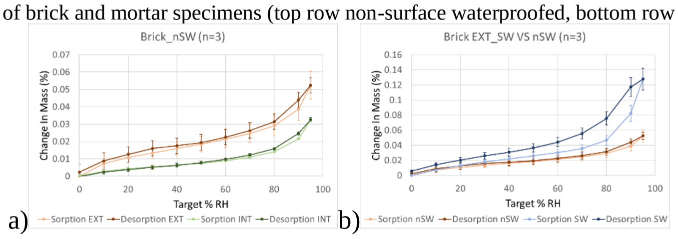

Figure 2 DVS Isotherm curves of a) exterior and interior brick specimens, b) untreated and treated exterior brick specimens

Figure 2a shows the DVS results comparison between specimens taken from exteriors and interiors of untreated brick, with the aim of studying the uniformity of the brick medium. The 3 specimens from the exterior of untreated brick have an average peak of 0.052% moisture content at 95%RH, while the interior ones reached 0.033% at 95%RH. The interior specimens have a more consistent performance and lower average mass change compared to the exterior ones. In Figure 2b, not only the mass change rate has increase on the treated exterior brick specimens, but the hysteresis between sorption and desorption also increased significantly. Before treatment the exterior specimens reached 0.052% moisture content at 95%RH but after treatment it increased 2.5 times. The increased error bar values also indicate the consistency has reduced after treatment.

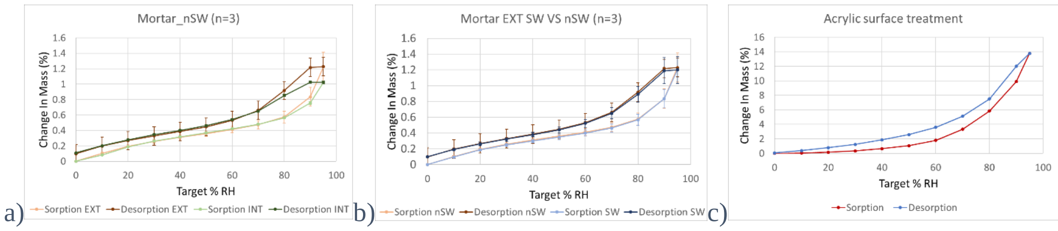

Figure 3 DVS Isotherm curves of a) exterior and interior mortar specimens, b) untreated and treated exterior mortar specimens, c) dried acrylic treatment

In Figure 3a, the exterior mortar specimens reached 1.23% at 95%RH while interior ones reached 1.02%. Owed to the homogenous medium due to mortar produced in the controlled lab environment, both specimens showed very close mass change rate until around 80% RH along the sorption and 70% along the desorption paths, although the difference is still quite limited. From figure 3b we can conclude that the acrylic treatment has brought minor impact on the moisture storage capacity of mortar. The untreated exterior specimens reached 1.23% at 95%RH while treated ones reduced slightly at 1.2%. Opposite to the increased moisture storage capacity observed on treated brick specimens, treated mortar specimens has slightly reduced the weight gain. Figure 3c shows the DVS test result of dried acrylic treatment. Unexpectedly, the dried surface treatment has a much higher moisture storage capacity compared to both brick and mortar specimens, reaching 13.78% at 95%RH.

In conclusion, the absorption test results showed the acrylic surface treatment have the capability of improving liquid water repellence performance of brick masonry. The treatment can maintain or even improve its water repellence performance over 24 months after treatment. However, the DVS test results indicate that the acrylic surface treatment may increase the moisture storage of treated masonry specimens, especially in high humidity conditions over 80%RH. The dried treatment itself has a much higher moisture storage capacity compared to the brick masonry substrate. Further research on comparison of different chemical-based surface waterproofing treatments in DVS test can devote to the understanding of impact of waterproofing treatments on the moisture behaviour of various construction materials.

References

[1] Aktas, Y. D., Zhu, H., D'Ayala, D., & Weeks, C. (2021). Impact of surface waterproofing on the performance of brick masonry through the moisture exposure life-cycle. Building and Environment, 197, 107844.Liddell, C., & Morris, C. (2010). Fuel poverty and human health: A review of recent evidence. *Energy Policy*, *38*(6), 2987-2997.

[2] Aktas, Y. D., D'Ayala, D., Blades, N. & Calnan, C., (2017). An assessment of moisture induced damage in Blickling Hall in Norfolk, England, via environmental monitoring. Heritage Science, 5(5)

[3] BSI, (2016). BS EN ISO 15148:2002+A1:2016 Hygrothermal performance of building materials and products — Determination of water absorption coefficient by partial immersion, s.l.: ISO.

[4] BSI, (2021). BS EN ISO 12571:2021 Hygrothermal performance of building materials and products - Determination of hygroscopic sorption properties.

[5] Sahoo, S. C., Sil, A., Thanigai, K., & Pandey, C. N. (2011). Use of silicone based coating for protection of wood materials and bamboo composites from weathering and UV degradation. Journal of the Indian Academy of Wood Science, 8(2), 143-147.

[6] Maclean, N., Walsh, E., Soundaranathan, M., Khadra, I., Mann, J., Williams, H., & Markl, D. (2021). Exploring the performance-controlling tablet disintegration mechanisms for direct compression formulations. International Journal of Pharmaceutics, 599, 120221.