COMPARING WATER REPELLING PENETRANTS ON ANTIQUE MASONRY

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ABSTRACT

Antique, or low fire, brick has suffered critical damage from mortar repairs of Portland Cement in the US, specifically water damage as moisture cannot move equally through low fire brick and Portland Cement. Effects of such an intrusion of water include spalling, stains, efflorescence, algae growth, and a decrease in insulating properties. The best way to continue preservation is to block moisture from entering the brick or mortar by using a water repelling penetrant. This research will compare the most widely used penetrants, siloxane and room temperature vulcanizing (RTV) silicone on low-fire brick and determine which product is best for preserving the masonry. Water repelling abilities as well as water vapor permeability will be tested using Rilem tubes, a freeze/thaw chamber, as well as simple weight comparisons to determine water absorption. Different characterizations techniques will be used in order to assess the optimum properties of the water repellent coatings.

INTRODUCTION

The purpose of this study is to combat moisture damage on historic brick buildings. It is not possible to repair the damage done with the Portland Cement repairs, but it is possible to mitigate further moisture damage. This study compared the two main functions of a rain repelling penetrant:

1. To stop water from entering the substrate in its bulk form.

2. To allow water vapor to permeate the substrate and escape.

Our conclusions on performance are based on those two functions. All tests were done will be done in accordance with the appropriate American Society for Testing and Materials standards.

DESIGN

A mock structure was used to test the two performance categories with a RILEM tube

Mock Structure

RILEM Tube

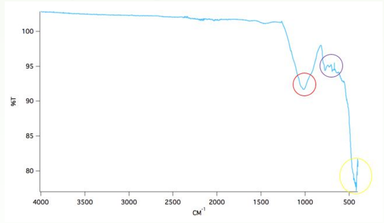
CHARACTERIZATION

The brick was characterized to determine the amount and type of metallic elements present using X-Ray Fluorescence (XRF), X-Ray Diffraction (XRD), and Fourier-transform infrared spectroscopy (FTIR).

This characterization was important because the penetrants bond to silica and alumina present in refractory brick. We needed to know if we had those elements present and what form they were in to determine if our penetrants were going to bond successfully and preform the two expected functions.

FTIR

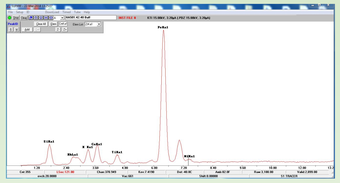
FTIR is a technique used to obtain an infrared spectrum of absorption, or emission, of a solid, liquid or gas.



The resulting graph has 3 identifiable peaks: ~990 cm-1 (Red circle) which indicates an Si-O bond, ~550 cm-1 (Purple Circle) which indicates Al3+-O2- bonds, and ~480 cm-1 (Yellow Circle) which indicates Fe3+-O2- bonds.

X-RAY FLOURESECNCE

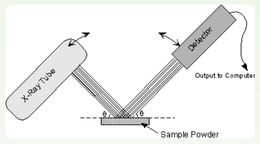
XRF is a non-destructive analytical technique used to determine the elemental composition of materials. XRF analyzers determine the chemistry of a sample by measuring the fluorescent (or secondary) X-ray emitted from a sample when it is excited by a primary X-ray source.

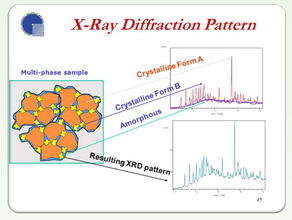


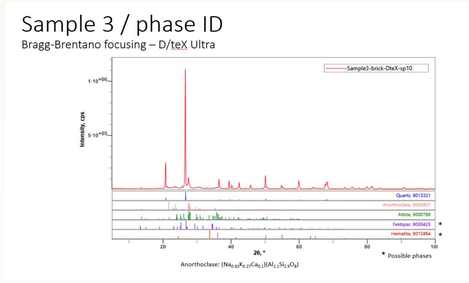
Results indicate there is iron, which is expected as Hematite (Fe2O3) gives the brick its characteristic red color.

X-RAY DIFFRACTION

XRD is the scattering of X-rays by the regularly spaced atoms of a crystal, useful in obtaining information about crystalline structures.

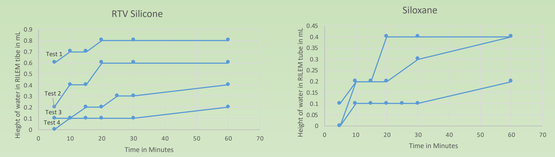






The peak matching show strong indicators of Quartz, Anorthoclase, Albite, Feldspar and Hematite. Using Rietveld refinement to estimate relative amounts we find Quartz is the most abundant crystalline structure in our brick at 62.9% and Hematite is the lowest at just 0.18%.

RILEM TEST RESULTS



There is not enough data for conclusive results at this time. From the limited set of results the siloxane has preformed better than the RTV silicone at repelling water. This is only one function of a water repelling penetrant and it is imperative that before we draw conclusions we test both functions extensively.

FUTURE WORK

1. Continued weekly measurements with the RILEM tube for further data gathering
2. Water vapor permeability testing from ASTM E514

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