EFFECTIVITY OF SEALANTS ON LIME PLASTER

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ABSTRACT

This experiment tested the performance of two sealants on a lime plaster wall. We compared the effectivity of Diamond Corporate Express polymer sealant and Olive Oil Soap sealant at keeping moisture out of the wall. Moisture must be present for mold to grow so by sealing the wall the ability for mold to grow internally on the wall is eliminated. The house we examined, 1960 Grant St in Eugene, OR has many natural finishes including sealed lime plaster in the bathrooms. The shower has mold growing around the base of the Polymer sealed lime plaster wall, so we decided to test the effectiveness of a sealant at keeping moisture out of the wall.

1. INTRODUCTION

This paper details the design and execution of an experiment which tests the properties of sealants for lime plaster. It was completed as the final project in the course Environmental Control Systems at the University of Oregon, winter term, 2010.

The building we chose as our case study is located at 1960 Grant St. in Eugene, OR. It is a 1500 sq. ft. single family home with two bedrooms and two bathrooms. A renovation finished in May 2009 involved retrofitting the house with a variety of natural building materials. The bathrooms were finished with lime plaster and sealed. The shower walls were sealed with the Diamond polymer and the tub bathroom walls were sealed with Olive Oil Soap.

The shower walls were showing mold growth so we decided to look at the properties and effectiveness of the two sealants on lime plaster. (Fig. 1) We wondered why there was mold growing when the lime plaster wall had been sealed with the Diamand polymer. (Fig. 2) According to the EPA, mold growth can occur on any surface as long as there is moisture present. Growth can be minimized by reducing moisture content, increasing air movement or increasing the air temperature. There have been attempts to remove the mold with surface cleaner, so we determined that the mold is growing on the plaster itself (rather than the surface). The other bathroom in the house has lime plaster walls sealed with olive oil soap. (Fig. 3) There is no mold growing on any of the walls in this bathroom, but it contains solely a bath tub and it not used for regular bathing - which results in high humidity and water present on the walls. While the mold growth could be attributed to a variety of factors including ventilation, air flow, temperature, and sealant, we decided to focus our study on the effectiveness of the sealant applied to lime plaster by testing the resistance to moisture penetration. We concluded that a study of the materials would be beneficial for homeowners or builders who may be interested in using natural materials in renovations, such as lime plaster or olive oil soap. We tested to see if the olive oil soap is as effective as the polymer sealant as a moisture barrier.

Background of Materials

Lime Plaster

Originates from Limestone, a sedimentary rock formed from compacted marine skeletons, which is heated and mixed with water to form lime putty. This putty reacts with the carbon dioxide in the air and slowly returns to it's original state, calcium carbonate (limestone). This is mixed with two to three parts sand to form a plaster. Most wet-applied plaster finishes are sufficiently air impermeable and their ability to absorb water is highly variable according to a study on the permeability of lime plaster compared to cement stucco (Straube 2000). Application of the plaster is in two coats, the rough coat and the finish coat. The finished thickness is usually 3/4-1 inch. After 3-5 days, the plaster has cured and hardened sufficiently for sealing. At this stage, the moisture content should be about 8%.

Polymer Sealant
Diamond Corporate Express-Dual Polymer Floor Finish:
A polymer is made up of a large number of similar small molecules, called monomers, which are joined together chemically. The chemical process of making a polymer is called polymerization. The polymer emulsions are the workhorse of a floor finish. Most floor finish polymer emulsions are made from acrylic or styrene type monomers.

Olive Oil Soap
Also known as Black Soap, it is composed of olive oil and mineral salts. It is applied to cured plaster in several coats with a metal trowel, then rubbed into the surface of the plaster with a stone. Black Soap is only made in Morocco and is an expensive material to purchase in the Pacific NW. In the case of this bathroom wall, it was applied with the Moroccan Tadelakt technique, which involves rubbing with a smooth stone to create a smooth sealed finish.

Fig. 1: Mold growth on shower wall

Fig. 2: Bathroom with polymer sealed walls

Fig. 3: Bathroom with Olive Oil Soap sealed walls

2. HYPOTHESIS

After exposure to water the olive oil soap sealed wall will have a moisture content 10% lower than that of a polymer sealed wall.

3. METHODOLOGY & EQUIPMENT

Methodology

We decided to construct sample wall squares since standing walls could not be easily tested due to the difficulty in controlling for variables, such as moisture content in the walls, sampling the inside of the wall, regulating external temperatures, and accounting for any past influences to the wall system (mold growth, soap, existing water). We isolated the other influences in the existing bathroom to test the effectiveness of sealants to repel water when applied to a lime plaster wall.

Test Sample Construction

The first step was to construct three separate lime plaster test walls: one control, one sealed with Olive Oil Soap, and one sealed with the Diamond Polymer. All of the samples were within the same environment conditions during curing and testing. We cut drywall scraps to 12"x10" pieces and applied metal lath with drywall screws. (Fig. 4) We moistened the drywall samples with water, then troweled on the base coat of lime plaster. We let it cure for 3 days, then applied the top coat.

Base Coat: Type S Lime (equilvaent to NHL 3.5 and available in Eugene, OR) 3 parts coarse sand (such as Mason sand) to 1 part lime. Water was added and mixed with an electric drill and paddle mixer. The lime was mixed until it would hold together in small balls. This was troweled onto the metal lath, about 5/8 of an inch thick. (Fig. 5)

Top Coat: Two parts 70 grit silica sand to 1 part NHL 2 lime. Water was added with electric drill paddle mixer until the consistency was like pancake batter. This was troweled onto the test squares at 1/8 –3/16 of an inch thick. (Fig. 6)

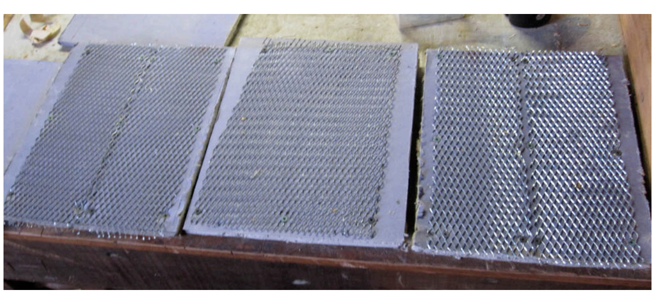

Fig. 4: Drywall samples with metal lath

Fig. 5: Troweling plaster on test square

Fig. 6: Completed test sample

Test Sample Methodology

There were 3 test wall samples used in the experiment. Sample 1 had lime plaster with no sealant and was sampled prior to applying water and after water was applied. Sample 2 had the Olive Oil Soap sealant applied over the lime plaster, and Sample 3 had the Polymer sealant applied over the lime plaster. (Fig. 7)

On March 1st the samples were tested for water permeability. To keep the amount of water applied to each sample the same, we taped off a section in the center of the sample and sealed the edges with a plastic bag. (Fig. 8) Then we directly applied water to each sample, measuring from the spray bottle so that each sample received 2 oz of water. We let the samples sit for 18 hours then removed core samples using a hole saw and a drill press. (Fig. 9) These samples were brought to the chemistry lab, weighed on a analytical balance, and put in a kiln to dry overnight. (Fig. 10) The samples were weighed 24 hours later, and with the wet and dry weights the water content was determined.

<u>Testing Timeline</u>

FEB 16: Base coat of plaster applied
FEB 19: Top coat of plaster applied
FEB 25: First coat of sealant applied
FEB 27: Second coat of sealant applied
MAR 1: Soak with 2 oz water
MAR 2: Remove core samples
MAR 2: Initial weight of core samples, 24 hrs in kiln
MAR 3: Dry weight of core samples

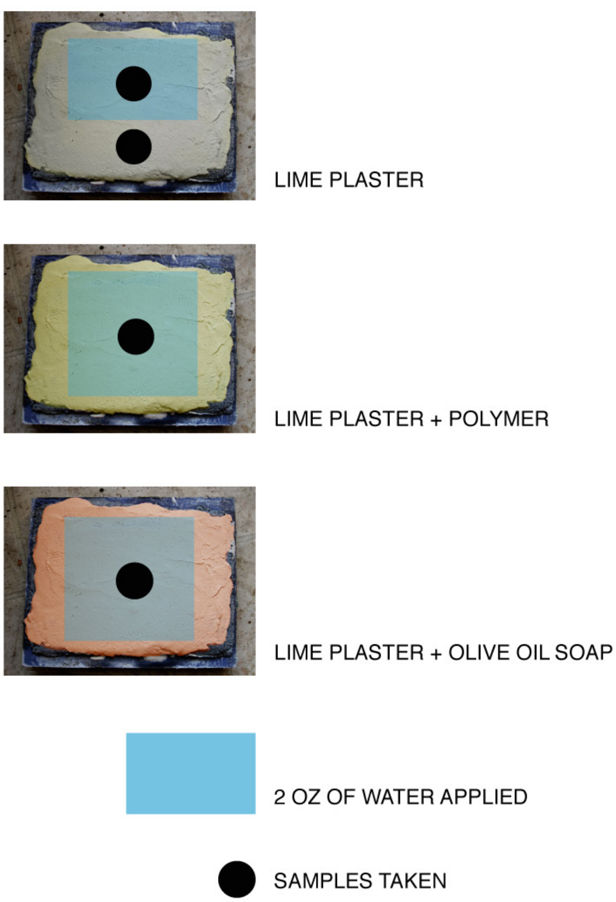

Fig. 7: Diagram of methodology

Fig. 8: Sealed test sample

Fig. 9: Test sample post drilling

Fig. 10: Weighing the samples

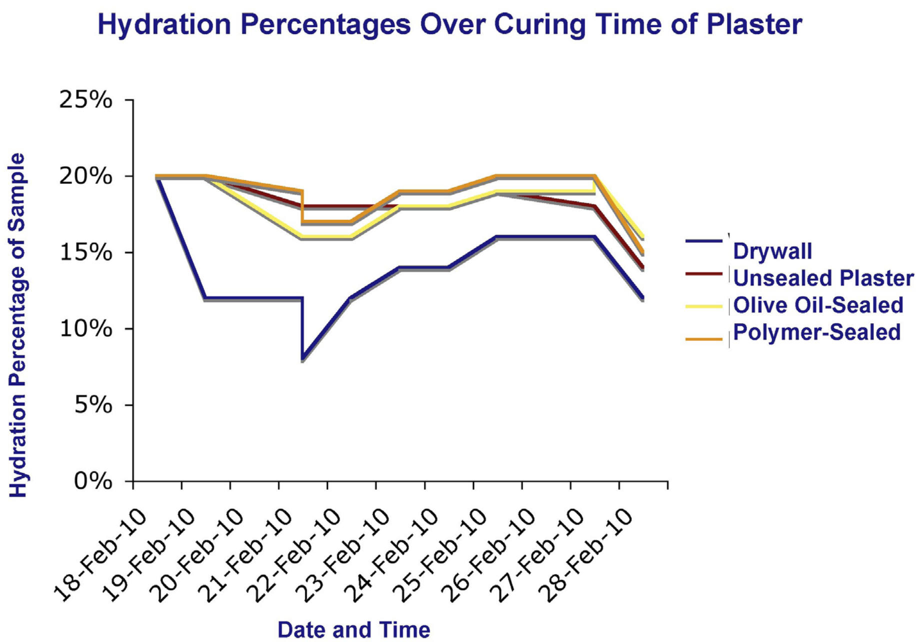

Fig.11: Water content during curing

We monitored the moisture content in the drywall of each sample as the lime plaster cured with a Mini-Lignos moisture meter. Fig. 11 shows the increased water content in the samples with the lime plaster since these had significant water applied in the form of the lime plaster and continual spraying while they cured. The drywall samples also fluctuated a bit due to sunny, dry days, increases in room humidity, and potential inaccuracies in the moisture meter. This information was not used to determine the water content of our sample cores after testing, it was used as a way to track and monitor the samples during construction.

Equipment

Construction-Drywall, metal lath, drywall screws, Type S Lime plaster, St. Astier NHL 2 lime plaster, coarse sand, mason sand, water, spray bottle, olive oil soap, Diamond Corporate Express Polymer Sealant, electric mixer, plaster trowel, Moisture Meter Mini-Lignos

Testing-Duct Tape, plastic, Drill press, analytical balance, drying oven

4. RESULTS

In order to determine the mass of the water which was contained within the sample, the final (dry) mass was subtracted from the initial (wet) mass of the samples (Table 1). The percentage of water in each sample was calculated by dividing the water mass by the initial mass, this is the water that evaporated during the kiln drying. The control test (Unsealed Plaster Dry) had two samples taken and an average was calcuated. This shows the water content of 7.45% in the lime plaster wall without any external water applied. By subtracting the control water content from the water content of each test sample we determined the water in the wall assembly due to the applied water.

5. DISCUSSION

Table 1 shows that the sample sealed with Olive Oil Soap contained less moisture than the sample with polymer sealant at the time of testing. The unsealed sample contained slightly less moisture than the sample with polymer sealant. When applied, the moisture was observed to soak into the plaster almost immediately with little or no pooling of water on the surface of the sample, so these results might relate more to the breathability of the sealant rather than its moisture blocking properties. We theorize that the difference could be due to evaporation of the water over the period between the wetting and the testing, which was 18 hours in our case. This is potentially due to the olive oil soap sealant being more permeable than the polymer sealant and allowing evaporation of the applied water to occur.

Even though both sealants allowed the plaster itself to be exposed to moisture, the olive oil soap allowed the plaster to dry faster than the polymer sealant. The drier the wall is, the less vulnerable it is to mold growth as well as decay. Based on these results, olive oil soap is as effective as, and even slightly better than, polymer sealant for the purpose of reducing water in a lime plaster wall. (Fig. 12)

TABLE 1: COLLECTED DATA OF WALL COMPONENTS

Sample	Initial Mass (g)	Final Mass (g)	Water Mass (g)	Moisture Percentage	Corrected Percentages
Unsealed Plaster, Dry A	79.51	74.43	5.08	6.4	
Unsealed Plaster, Dry B	64.55	59	5.55	8.6	
Unsealed Plaster, Avg.	72.03	66.72	5.31	7.45	
Unsealed Plaster, Wet	62.43	56.24	6.19	9.9	2.45
Soap Sealant	65.38	59.55	5.83	8.9	1.45
Polymer Sealant	53.58	48.21	5.37	10	2.65

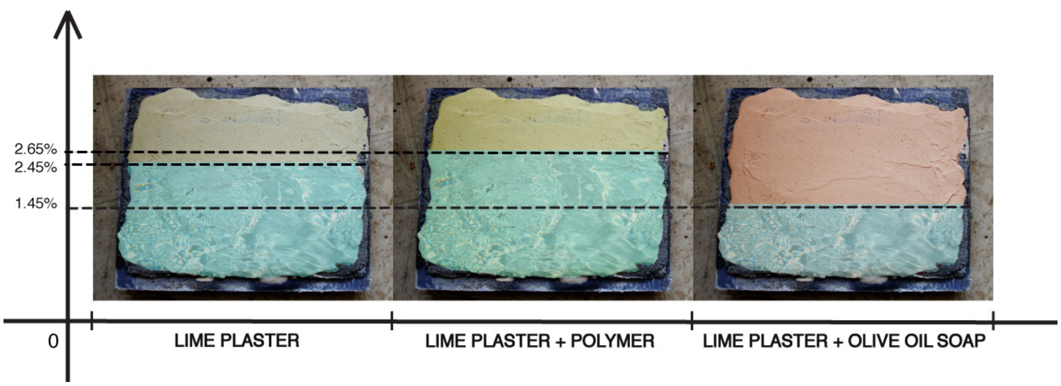

Fig. 12: Percentage of water in wall samples

If we were to conduct this study again, there are several additions to the methodology which could increase the accuracy of the results. The greatest change would be to increase the duration of the study by first giving the plaster and sealants a longer drying time. Use of a more accurate moisture meter during drying time and a more accurate water delivery system would help reinforce the results. This study could be expanded upon by conducting tests with varying amounts of water applied, and testing moisture content of samples over time after being exposed to water to determine the breathability of the sealants.

6. CONCLUSIONS

We conclude that the olive oil soap sealed wall had less water penetration than the polymer sealed wall after exposure to moisture. The soap sealed wall sample had 1% lower moisture content than the polymer sealed wall. Based on our results our hypothesis was incorrect in the amount of effectiveness of Olive Oil Soap sealant over Diamond Polymer. We did find the Olive Oil Soap sample had less water and therefore was slightly more effective than the polymer sealant at keeping moisture out of the wall.

7. ACKNOWLEDGMENTS

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