

Nile Theater Mortar Analysis

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Historic Preservation offers a variety of important tools that can help residents and business owners retain the historical character and integrity of the built environments we inhabit, the places where we all enjoy spending time because of the historical features. One tool is the analysis of materials, particularly mortar. Mortar does more than merely hold a brick in place. It serves as a shock absorber so that when a building moves as a result of settling, rain, heat or cold, the mortar—not the masonry—absorbs that movement. As such, the mortar should never be stronger than the material to which it adheres. When a stronger, denser mortar is used (see illustration below), the masonry is forced to absorb the movement, and could even



This masonry wall is now honeycombed with spalling and deteriorating stone due to the excessive strength of the mortar—in this case, Portland cement.

spall from the excess intake of moisture. This is particularly important information since here in the Phoenix Valley bricks tend to be softer. The bricks are not substandard, they are just soft. Since our climate does not include freeze/thaw cycles, these bricks age well.

Recently the Nile Theater was selected as one of the first buildings to undergo Mesa's downtown colonnade removal. And, the theater is also part of the downtown Pass-Through grant obtained recently from the State Historic Preservation Office (SHPO). Together, these projects are working to restore and protect the historic downtown commercial district. The Nile Theater opened in 1924 as the Valley's first and largest movie house.¹ An inspection of the brickwork indicates that the brick and mortar are original with minimal repair and minimal repointing using a stronger mortar: Portland cement.

On October 31, 2017, Lauren Allsopp met with Michelle Donovan of the Nile Theater. The meeting was to obtain additional original mortar samples due to the limited availability at the

ground level. Bricks and mortar on the rear, south wall were painted and the east wall was largely inaccessible due to a locked gate. Several samples were obtained and those taken from the east wall below the parapet—Sample A—and the southeast corner of the east wall directly above the gate—Sample B—yielded the largest amount of information.

Analysis includes establishing the original binder to aggregate ratio and determining the grain size distribution. The results are used to identify the repointing recipe and materials that should be avoided. Each sample from the Nile Theater was independently analyzed, then compared once all results were in. Each sample was ground and weighed, then dissolved in hydrochloric acid (HCl). Acid dissolves binders such as hydrated lime, but generally does nothing if the binder is Portland cement. After washing away any remaining acid, then dried, the sand was run through a series of ASTM sieves.² Only one sample was partially analyzed. The sample taken from the northeast corner of the north parapet did not grind well and had no reaction to HCl. The color was grey. These are all characteristics of Portland cement and probably dates from the time the theater was stuccoed, perhaps from the mid-1980s when the colonnades were added. It bears repeating that Portland cement should **not** be used on the soft bricks of the Valley.



Preparatory equipment

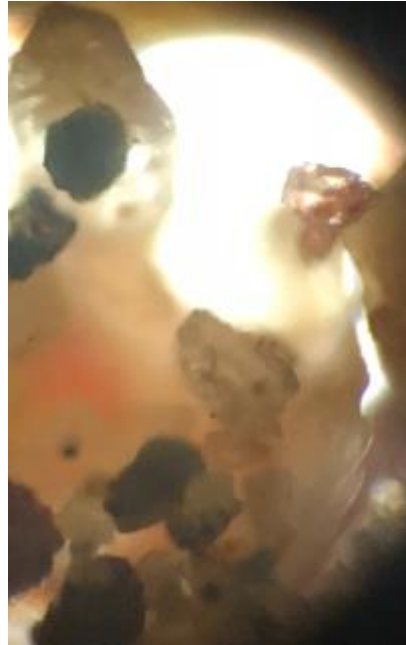


Excessive bubbling indicates a lime binder

Sample A's binder to aggregate ratio was 1:4 or 1 part hydrated lime to 4 parts sand. Sample B's ratio was identical. In preparing mortar for any future repointing, **the binder should only be lime and used in a 1 to 4 ratio with sand**. Marcus Vitruvius Pollio, a Roman author and architect, wrote a book entitled *De architectura*—translated as *The Ten Books of Architecture*—in 30-20 BCE. He wrote volumes about mortars and cited the best ratios to use with brick were either a 1:2 or 1:3.³ If river sand was used or if bricks were softer, the aggregate was increased. The Nile Theater mortar ratio exhibits this trend. Examining the Nile Theater sand under a microscope (see illustration below), the sand grains are angular. The characteristics of pit sand are its angularity due to their stagnant position in the landscape. River sand or sand culled from moving water would typically be rounded as they roll around in their natural environment.

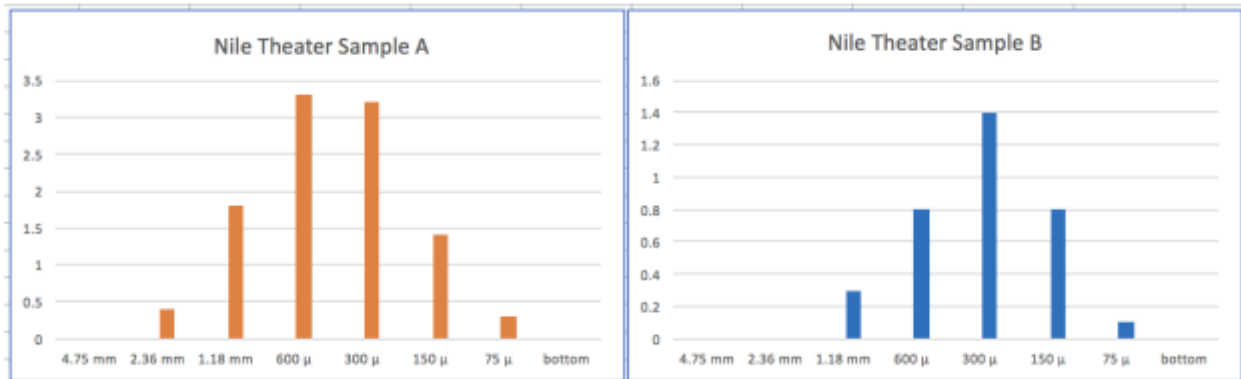


Weighing the sand in each sieve



Sand grains seen through a microscope

Finally, the sand grains were run through the fore-mentioned ASTM sieves and the following graphs were created from the data. If a precise sand match is wanted in restoration work, a sample of the proposed pit sand should be obtained and run through the ASTM sieves.



In conclusion, the Nile Theater is constructed of a local brick and a mortar, that while softer, is best suited for the brick. These characteristics should be kept in mind when repointing.

- The binder/aggregate or lime/sand ratio should be 1:4 or 1 part hydrated lime to 4 parts sand.
- The mortar should always be softer than the material—in this case, brick—to which it adheres. Portland cement should **not** be used as it will harm the masonry and cause greater problems later.

- The restoration sand should be pit sand to retain the original angularity. By using a local quarry source, a close color match can also be achieved.
- If possible, the pit sand should match—in grain size—the graphs above. The bulk of the sand grains should be 300 – 600 μ .
- The existing mortar joint should be matched. It is called flush (see illustration below). Note, the graininess of the sand in the joint. This should be replicated if the 1:4 ratio is used.
- The porosity of the brick suggests that if painted, the paint will probably not be able to be removed without the baked surface of the brick spalling off. This will expose the interior and the honeycombed effect noted above will occur.
- Any stucco recipe should be treated like a coating of mortar and use the same mortar recipe of 1:4 lime:sand.



¹ The Nile Theater, <https://www.niletheater.com/about/> (accessed November 28, 2017).

² American Society for Testing and Materials (ASTM) provides standards for the products we use, <https://www.astm.org/> (accessed November 28, 2017).

³ Marcus Vitruvius Pollio, *The Ten Books on Architecture*, translator Morris Hicky Morgan (New York: Dover Publications, 1960).