PRESERVATION
Tech Notes

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Preservation Assistance Division

MASONRY

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Water Soak Cleaning of Limestone

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THE WIDENER BUILDING
Philadelphia, Pennsylvania

Constructed in 1914 by Philadelphia industrialist Peter A.B. Widener at a cost of eight million dollars, the Widener Building reflects the major development of the business and financial district centered around City Hall at the turn of the century. Designed by the noted architect Horace Trumbauer, this eighteen-story, steel-framed office structure with its glazed terra cotta cornice, smooth-finished Indiana limestone veneer and granite base, typifies the height of the Renaissance Revival architectural style applied to a multi-story commercial office building. The Widener Building continues to function as an office building and is a contributing structure in the Broad Street National Register Historic District.

Prominently located across from City Hall, the building has endured a number of misguided attempts at

Masonry should be cleaned using the gentlest means possible.

modernization to recapture the prestige and luster of a first class office building. The most drastic alterations occurred in 1963, when the elaborately detailed arcade that connected Chestnut Street with South Penn Square was closed off to pedestrian traffic. At the same time, the original limestone and bronze commercial storefronts on Chestnut Street were replaced with a contemporary design of marble, glass and aluminum that was incompatible with the historic character of the building. Other than these changes at street level, the exterior was unaltered and had never been cleaned (*see figure 1*).

In June of 1989, a forty million dollar rehabilitation of the Widener Building began. The rehabilitation included the overhaul of the building's mechanical/HVAC systems, renovation of the office spaces, and restoration of the exterior that included masonry cleaning, repointing, and reopening the historic arcade.

Problem

The rehabilitation of historic buildings often includes the cleaning of the masonry. Removal of the deleterious deposits of particulate matter from the stone's surface generally enhances the appearance of an historic building and in the case of calcareous stones, furthers the long-term preservation of the masonry by eliminating whatever is damaging the fabric. Since the Widener Building had been subjected to seventy-five years of exposure to an urban/industrial environment and had never been cleaned, the masonry surfaces were heavily coated with typical deposits of air-borne particulates of soot, fly ash, tar and clay matter as well as localized areas of organic matter. These deposits in conjunction with sulfur oxides accelerate the decay process of the calcareous stones such as limestone by forming non-stable, highly soluble and chemically-reactive crusts that increase the stone's surface area and ultimately leave the stone more vulnerable to damage from continuing deposition attack.

Figure 1. In 1989, just prior to the onset of the rehabilitation project, the Widener Building was showing the effects of 75 years of exposure to an urban environment. Note the lighter color of the left side of the building regularly washed by rain. Photo: John Milner Associates.

In addition, before an accurate survey and assessment could be made of the condition of the masonry, the stone needed to be cleaned to observe cracks, surface defects, areas of active movement and required repointing.

Once the decision had been made by the new owners to clean the masonry, an appropriate cleaning system had to be selected, taking into consideration potential problems and liabilities associated with each method. Adequate testing had to be carried out to ensure that the process did not damage or alter the masonry, or adjacent buildings, and that it did not adversely impact tenants working in the building or pedestrians and vehicles passing below. All applicable environmental, health and safety, and potential liability issues, including the disposal of waste water, had to be addressed and resolved before a final decision could be made. The cleaning would have to conform with the City of Philadelphia Water Department's regulation that prohibits the disposal of a wide range of types of chemical discharge (regardless of their dilution rates) directly into the city's storm and sanitary sewers. In addition, the Environmental Protection Agency (EPA) has a national policy that prohibits any substance with a pH of less than 5 from being discarded into any sewer system.

Solution

The stated goal of the cleaning as specified by the restoration architect was that the "cleaning of limestone will be limited to removal of surface dirt. No attempt will be made to create a brand new appearance." To achieve that goal, test patches (approximately $3' \times 5'$) using three different cleaning methods were carried out in the Spring of 1989 on limestone ashlar blocks on the 4th floor of the South Penn Square elevation. These patches were then evaluated according to the following criteria: possible damage to the stone surface; how well each of the techniques cleaned the stone; and the ease of operation of each cleaning system.

The three systems that were tested included a simple, timed water-soak cleaning method, and two types of alkaline-based chemical cleaners, both specifically formulated for cleaning limestone.

Water Soaking: Prolonged, timed soaking is a relatively simple washing method that can be especially good for loosening dirt and pollutant crusts such as the kind that disfigured much of the limestone surfaces of the Widener Building. This technique is effective because the gypsum crust that incorporates the dirt is much more water-soluble than the limestone substrate. The timed water-soaking gradually dissolves and loosens the pollutant crust, and in a second step the residue is then rinsed off the masonry with medium pressure water washing. Although timed water soaking has not been used extensively in the United States, it is regularly employed (often in a highly sophisticated manner) in the cleaning of historic structures throughout Europe.

For this test, the limestone was soaked for 4 hours with low-pressure water from an oscillating sprinkler in order to dissolve and loosen the pollutant crust. After the 4-hour soak, the loosened crust and remaining particulate matter were rinsed off the stone surface by a pressure washer with a 45 degree fan tip nozzle at 400 pounds per square inch (psi) using approximately 5 gallons of water per minute (gpm) (*see figure 2a*).

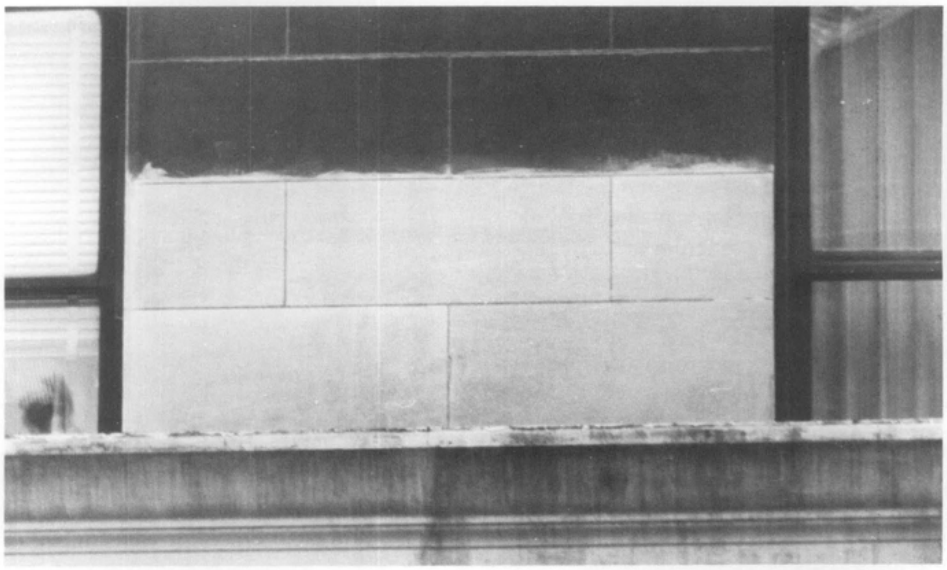
Two Part Chemical Cleaner: This two-part system is intended for heavily soiled limestone surfaces and employs a sodium hydroxide-based cleaner (with a pH of 14) used in conjunction with an acetic acid-based neutralizer (with a pH of 1.6). The limestone area to be treated was pre-wet with a water rinse before the sodium hydroxide-based cleaner was applied full strength to the stone with a synthetic deep nap roller and

allowed to remain on the surface of the test patch for approximately 30 minutes. The treated area was then thoroughly rinsed at a pressure of approximately 400 psi at 5 gpm using a 30 degree nozzle. Immediately after rinsing, the acidic neutralizer was applied (diluted 1:1 with water), to the wet stone with a deep nap roller. The neutralizer was left on the surface for 3 minutes, and then the stone was fully rinsed with water (*see figure 2b*).

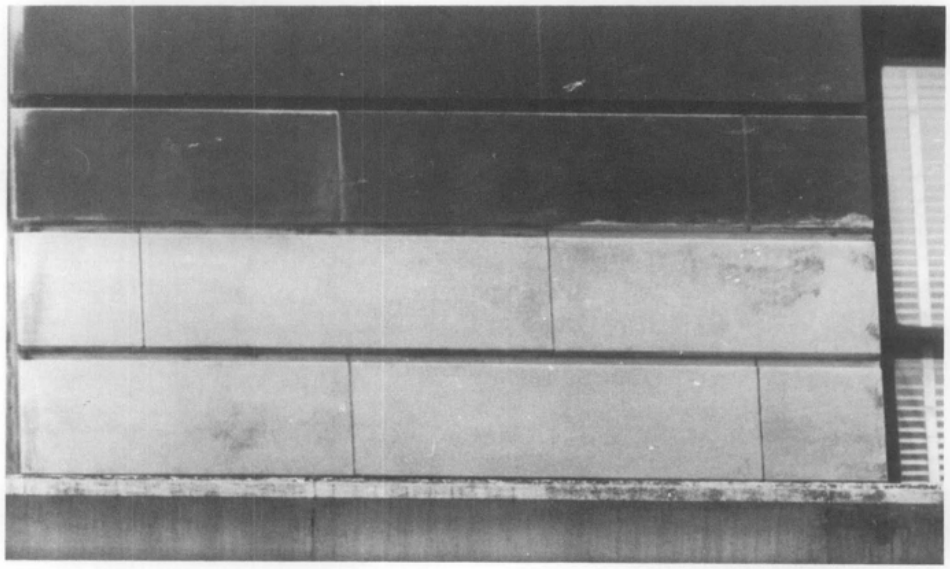
One Part Chemical Cleaner: The second type of chemical cleaning tested was also an alkaline-based cleaner, and it too is intended to be used on limestone. It consists of a fluoro-chemical surfactant containing carbonate emulsifiers (pH of 10). It was applied full strength to the dry surface of the stone with a deep nap roller, allowed to remain on the surface for approximately 5 minutes and then rinsed with a pressure washer delivering water at 600 psi at 5 gpm (*see figure 2c*).

After allowing the test area to weather for a sufficient period of time, a thorough examination of the three test panels was made. Based on that evaluation, the development team decided to proceed with *water soaking*, the first method tested because that panel appeared to best represent the cleaning goals stated by the project architect. Selection of the water soak method, rather than either of the chemical methods, was based on the following factors: 1) the stone was not damaged; 2) the test patch had achieved the highest level of even cleanliness without bleaching or "creating a brand new appearance;" 3) the process was very simple and efficient; 4) it was very cost-effective (approximately one-half the cost of the chemical cleaning processes); and 5) it eliminated the need for a barricade and a collection system for the runoff, or the need to dispose of effluent off-site which would have been required by the City of Philadelphia Water Department had chemicals been used. The chemical-free water soak system was environmentally safe, and the work could be scheduled primarily in the evenings, further minimizing disruption to office tenants, pedestrians and vehicles.

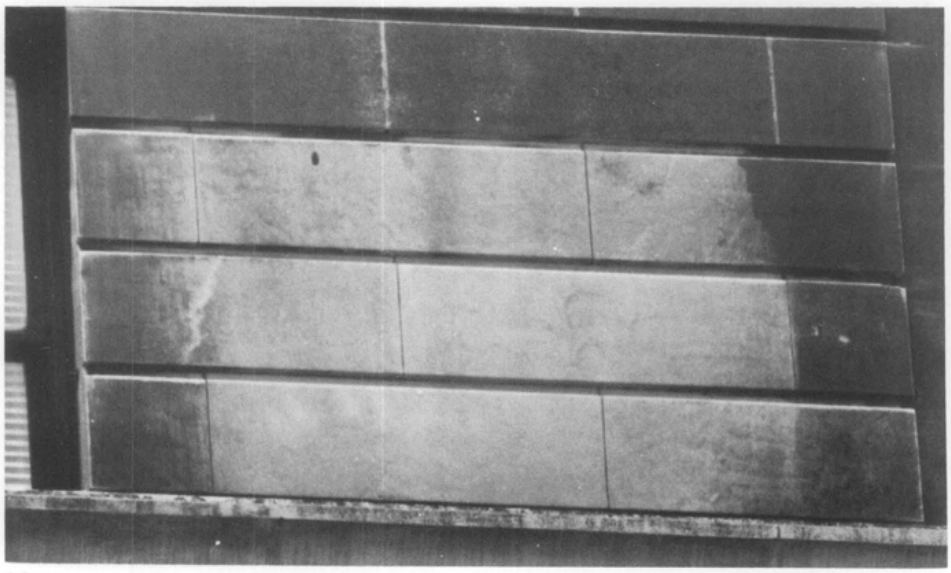
The water soak method employs



(a)



(b)



(c)

Figure 2. The three test panels were carried out on the right side of the 4th floor of the South Penn Square elevation directly above the cornice that tops the 3-story storefront columns. (a) The completed panel on which the water soak method was tested; (b) the second completed panel after testing with the two-part alkaline chemical cleaner; and (c) the third completed panel after testing with the one-part alkaline chemical cleaner. Photos: John Milner Associates.

Figure 3. Close-up view of the oscillating sprinklers spaced 3 feet apart and connected to ¼″ PVC piping attached to the rear bar of each scaffold. Photo: P & R Masonry Restoration, Inc.

large amounts of water, and thus had to be completed well before there was a threat of freezing temperatures. This was to avoid the possibility of damage that might result from water freezing inside the saturated masonry, which would cause the stone to spall. In addition, the water to be used for the cleaning had to be analyzed to determine if it contained potentially harmful substances that might be introduced into the stone. Based on information obtained from the City of Philadelphia Water Department, it was determined that unfiltered city tap water could be used since it was sufficiently pure. This water has a pH of 8.2, and contains the following minor impurities, identified below in parts per million:

Alkalinity as Calcium Carbonate	44.000
Hardness as Calcium Carbonate	100.000
Iron	0.060
Dissolved Iron	0.016
Dissolved Magnesium	0.010
Calcium	27.000
Turbidity	.240
TOTAL	**172.000**

Upon awarding the cleaning contract to the firm that had conducted the initial water soak testing, additional test panels were executed on the building's two other elevations on Juniper and Chestnut Street to determine whether conditions there differed from the area already tested on the South Penn Square elevation. These test panels revealed that there was a difference in the amount of encrustations on each elevation, with the south-facing Chestnut Street elevation being less heavily soiled than the north-facing South Penn Square elevation and east-facing Juniper Street elevation. Based on these additional tests, it was concluded that the less-soiled Chestnut Street elevation cleaning would require less soaking than either of the other two, and for this reason was selected to be cleaned first.

Work Description

Since the water soak process involves projecting unnaturally high amounts of water at the building, special measures were taken to protect it from water infiltration. The contractor caulked all the windows prior to the cleaning. Specially designed metal pans were fabricated to fit on the window sills to divert water, and prevent it from seeping into these vulnerable areas, but keeping the water flowing onto the masonry. Water was also diverted away from the base of the building at the sidewalks with polyethylene sheeting. Also, before any soaking took place, all areas of the building to be cleaned were inspected for missing mortar joints or other areas with the potential for water infiltration. However, since the entire building had been repointed in 1983, the mortar joints were generally in excellent condition. In those few situations where the joints were not weathertight and water infiltration was a concern, the joints were temporarily filled with a urethane caulk which was removed after the rinsing was completed, and necessary repointing carried out.

The actual cleaning process was simple and flexible allowing for modifications to address the specific conditions found at each location. Based on the contractor's experience with this system on previous jobs and the particular features of this building, the cleaning was started on the fourth floor (the floor just above the cornice that tops off the three-story columns defining the storefronts), working up the building. Two 40′ long swing scaffolds, operating concurrently and spanning half the elevation, were set in place. Ten oscillating-type lawn sprinklers, connected to 1¼″ PVC piping were attached to the rear bar of each scaffold. The sprinklers were spaced approximately three feet apart on the scaffold bar, set back five feet from the masonry surface, and trained to spray up and down the surface of the building covering a distance of about ten feet (*see figure 3*). These sprinklers were fed approximately ¾ gpm from a two-inch fire hose connected into the PVC line. Since the building's water distribution system could not deliver adequate amounts of water to the 20 sprinklers attached to the two scaffolds, the contractor utilized a surge pump attached to the distribution system that tripled the amount of water flowing to the sprinklers.

On both the Chestnut Street and South Penn Square elevations, water soaking of an area of the wall measuring about 40′ × 10′—the approximate area that could be covered from one scaffold—typically began about 7 p.m. each evening and continued overnight for 4 to 6 hours. A two-member crew set up the equipment for the evening's soak and a single crew member monitored and shut off the system. Soil on the Juniper Street elevation proved to be more tenacious and its removal necessitated a longer period of soaking up to 8 hours. Some difficult to clean or heavily stained areas required a double soak usually the day after completion of the first soak. In a few limited situations, a third, additional soak was necessary before the rinse process, which required that the scaffolding be brought back after it had been moved to another location.

Upon completing the soaking of the 40′ × 10′ area that could be covered from one scaffold, the scaffold was moved up to the next story, and the soaking process was repeated on up through the 9th floor. When the water

Figure 4. South Penn Square elevation after the completion of two drops from the 9th-4th floors of water soaking only, and prior to beginning the rinse process. Photo: P & R Masonry Restoration, Inc.

Figure 5. The drop on the left side of the building has been water-soaked and rinsed, while the drop on the right has been soaked only. Note the amount of soil that still remains on the right side before rinsing. Photo: P & R Masonry Restoration, Inc.

soaking had been completed on both drops (a "drop" is the amount of vertical wall surface that can be covered by one scaffold moving vertically up or down a building), the crew began the rinsing process this time moving down the elevation, starting from the 9th floor and proceeding to the 4th (*see figure 4*).

For the rinsing process, two pressure washers were placed atop the building with pressure hoses extending to the scaffolds. Each machine generated a pressure of 400 psi and 5 gpm. Throughout the cleaning, one worker per scaffold used a short-handled spray wand with a 30 degree nozzle to rinse away loose material and clean out the pores of the stone. The nozzle was kept a minimum of two feet away from the masonry surface at all times (*see figure 5*).

After cleaning (soaking and rinsing) the 4th through the 9th floors, both scaffolds were moved up to the 10th floor where the soaking process was begun again and was continued up through the 13th floor (*see figure 6*). This section was then rinsed, and the soaking process recommenced at the 14th floor and proceeded to the cornice at the top of the building.

The other two elevations of the building were washed in the same fashion. Each elevation took a 1 or 2 person crew approximately 5 weeks to complete, the crew typically working 1½-2 shifts per day, 6 days per week.

Project Evaluation

The successful cleaning of the three elevations of the Widener Building took about 4 months of regular soaking and rinsing to remove the heavily encrusted particulate matter. There were two minor problems with the cleaning. During the soaking process there was somewhat more water infiltration into the interior of the building than had been anticipated, especially in those areas with numerous windows. This problem could have been reduced by greater protection of these vulnerable areas by additional shielding and temporary caulking. However, given the amount of water used in the cleaning, the overall amount of infiltration was remarkably low, and did not result in permanent damage to the interior.

Secondly, it was apparent after the cleaning that some of the highly articulated decorative trim features and areas not regularly washed by rain directly below the window sills and returns had not been cleaned as thoroughly as the majority of the flat stone surfaces. Although these slight discolorations could probably have been eliminated by longer or additional periods of soaking, perhaps supplemented by poulticing or scrubbing with a natural bristle brush, they are few in number and do not detract from the overall quality of the cleaning project.

Water soaking is a cost-effective cleaning process for both large and small limestone buildings. The results of the cleaning of the Widener Building are startling, especially when compared to the appearance of the stone prior to the start of the project (*see figure 7*). Although the cleaning team was on the job site for a longer

Figure 6. The contrast between the cleaned and the uncleaned portions of the facade after completion of both the water soak and the washdown rinse of these two drops from the 14th-4th floors is dramatic. Photo: Robert M. Powers.

period of time than it would have been for a chemical cleaning job, the project was completed on time and within budget, *for approximately one-half the cost of a typical chemical cleaning system*. The stated goal of the restoration architect was clearly met. The limestone was adequately cleaned with water—"the gentlest means possible"—to remove the surface dirt without creating a brand new appearance.

PROJECT DATA

Building:
Widener Building
1339 Chestnut Street
Philadelphia, Pennsylvania

Owner:
Jeffrey E. Kelter
Widener Associates Limited Partnership
Philadelphia, Pennsylvania

Project Dates:
July 1, 1990-October 30, 1990

Contractor:
P & R Masonry Restoration, Inc.
Chester Heights, Pennsylvania

Restoration Architects:
John Milner Associates
Philadelphia, Pennsylvania

Project Cost:
The cost of using the water soak method to clean the 100,000 square feet of limestone was approximately one-half the cost of chemical cleaning.

Figure 7. The South Penn Square elevation after its successful cleaning using the water soak method. Photo: Faherty/Kelter Associates, Inc.

This PRESERVATION TECH NOTE was prepared by the National Park Service. Charles E. Fisher, Preservation Assistance Division, National Park Service, serves as the Technical Editor for the PRESERVATION TECH NOTES. Information on the water soak process described here was supplied by Phillip Scott of John Milner Associates and Rick Weber of P & R Masonry Restoration. Special thanks go to John Hnedak, Mid-Atlantic Region, National Park Service, and Anne Grimmer, Preservation Assistance Division, National Park Service, who coordinated production and provided editorial and technical comments. Cover Photo: View of the South Penn Square elevation of the Widener Building, circa 1916, two years after its construction. Courtesy: Philadelphia Historical Commission.

PRESERVATION TECH NOTES are designed to provide practical information on techniques and practices for successfully maintaining and preserving cultural resources. All techniques and practices described herein conform to established National Park Service policies, procedures and standards. This Tech Note was prepared pursuant to the National Historic Preservation Act Amendments of 1980 which direct the Secretary of the Interior to develop and make available to government agencies and individuals information concerning professional methods and techniques for the preservation of historic properties.

Comments on the usefulness of this information are welcomed and should be addressed to Tech Notes, Preservation Assistance Division, National Park Service, P.O. Box 37127, Washington, D.C. 20013-7127.

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