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Wish You Had A Crystal Ball? Projecting Your Building Envelope Maintenance Needs

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No couldn't use a crystal ball when it comes to anticipating building envelope maintenance, repair, and rehabilitation needs? While no one can predict the full range of maintenance, repair and rehabilitation work a building or complex may need over time, a **building envelope maintenance program** can come close. No smoke, no mirrors — just a factbased program that can be used to identify, plan, budget for, and manage everything from minor repairs and routine maintenance to full replacement of major building envelope components.

Successful facility management typically means maintaining a building at the lowest possible cost, operating within realistic annual budgets, and avoiding the high cost of emergency repairs.

Richard P. Kadlubowski, AIA, directs the firm's Washington, DC office. As Senior Architect, he helps clients develop building envelope maintenance programs that meet the specific needs of their facilities and their business objectives. His expertise lies in investigative and design services to correct deterioration problems within roofs, facades, and structural systems of existing buildings, plazas, and parking garages. He is currently at work on restoration of the Dome of the United States Capitol, and on a number of projects in Virginia, Maryland, Delaware, and throughout the District area. Whether managing a single building or a multi-building complex, it is essential that building owners and managers plan ahead for the regular upkeep, necessary repairs, and ultimate replacement of building envelope components.

A building envelope maintenance program is designed to do just that. It's a manageable way of looking at the complexities of the building envelope - roofs, facades, doors, windows, and developing an ongoing, evolving program of care for these elements. This program can be used to evaluate building conditions, to identify maintenance, repair, and replacement items, and to establish a time frame and budget for the work. More importantly, it's a way to help control costs by setting priorities, identifying the most costeffective scheduling of work, and catching minor problems before they escalate into major repairs.

The High Cost Of Not Planning Ahead

The fact is this: The building envelope *will* deteriorate over time. Today's roofing may endure 10 to 20 years. Manufacturers typically provide a 10-year warranty on joint sealant. Brick mortar joints may hold up for 25 years before needing replacement. But that is under optimal conditions, assuming perfection in design, materials, and installation. In reality, buildings are subject as much to the failings of human nature as to the



Accurately forecasting building envelope needs requires an in-depth look at current conditions. Here, one of the firm's senior architects (left) investigates deterioration in the masonry wall of a commercial high-rise.



While budget constraints may necessitate stop-gap measures such as this (wire mesh installed to prevent spalled brick from falling multiple stories to the ground below), the underlying cause of the deterioration shouldn't be overlooked. This brick corner and three others like it had gone unrepaired for many years, and ultimately had to be fully reconstructed, including replacement and re-positioning of the steel relieving angles.

forces of Mother Nature. Add to that the all-too-common need to defer repairs or maintenance because of inadequate maintenance budgets.

Yet putting off those minor repairs often results in major problems — with an associated jump in repair costs. Inflation accounts for part of that cost increase. Even with the relatively low inflation rate experienced during the past seven years, delaying a repair can still add up. For example, it cost \$20 per square foot in 1991 to replace a 37,000 square foot roof with a new EPDM roofing system.¹ Had the owner deferred that work, the cost today would be \$23.64 per square foot², an 18% increase in materials and installation that would add another \$134,680 to the project.

But the more dramatic cost increase caused by delaying work comes from the ongoing deterioration in building materials. It snowballs, to put it simply. Because building materials deteriorate at varying rates and a variety of factors can hasten deterioration, it is difficult to project or quantify the net financial impact of delaying repairs.

But it is safe to say that deterioration will only worsen over time. For example, in the re-roofing situation described earlier, deferring roof replacement could have led to water

¹ Based on Hoffmann Architects' 1991 actual project cost experience.

² This cost increase is based on the annual inflation rate data provided in *RS Means Construction Cost Data 1998, Historical Cost Indexes*, a nationally recognized standard reference on construction cost data.

In both cases, the cost per square foot is based on the contractor's cost of labor, materials, overhead, and profit for removing an existing roof and replacing it with a new EPDM membrane, insulation, sheet metal work, penetrations, and other associated roof work. infiltration into interior spaces, deterioration of the roof deck, and damage to other building areas. It follows, of course, that the greater the damage, the greater the cost of repair.

Or, consider the problem of a pinpoint leak in an EPDM roof membrane, which is, in itself, a minor repair item. After two years, however, repairing the damage caused by the pinpoint leak will be a little more involved. In just three to five years, those roof repairs will be significantly more extensive and expensive. Ultimately, without remedial action, full roof replacement may be in order. At today's roof replacement costs (which can range from \$4 or \$5 per square foot for a suburban low-rise or warehouse to \$100 per square foot or more for a downtown skyscraper), patching the pinpoint leak at its onset is the more prudent approach.

Clearly, delaying maintenance and deferring needed repairs can increase costs and exacerbate borderline building conditions. Planning ahead is the best way for building owners and managers to manage the financial impact of building envelope needs. Look at it this way: Wouldn't you rather know today that you'll need a new roof in five years, instead of facing an emergency roof replacement tomorrow?

A Plan For All Reasons

A building envelope maintenance program can be organized and presented in any number of ways to meet the owner's specific needs.

Here are some of the objectives a building envelope maintenance program can help achieve:

1. Establish a baseline on which to base a facility management plan by investigating and evaluating existing

The Snowball Effect

Often, building envelope deterioration problems can be traced to flaws in the original design. Here, the lack of expansion joints was identified as a major factor in the deterioration of this parapet and facade.



With no accommodation for the natural expansion and contraction of the brick face, this parapet wall, over time, began to roll inward. (The proper alignment is indicated by the red line drawn on the photo.)



That movement of the parapet wall resulted in displacement of the coping stones, creating in some cases — as shown here — up to a one-half inch differential in the stone surfaces. Aging sealant joints experienced cohesive failure under the stress, and led to openings into the wall, permitting water entry.



The ongoing stress also caused the displaced brick and sheared mortar joints shown here. Without repair, water may ultimately reach the embedded structural steel, causing rust and expansion, further displacing the brick facade.

building conditions. This review should include a look at the original building design, as-built drawings, and documentation of previous repairs. It should also include a visual inspection of all roof and facade elements to help form a full picture of the building's current conditions and anticipated maintenance needs. A formal written report of these findings, along with associated documents, such as original plans, specifications, and manufacturers' warranties, should constitute the framework of the program.

2. Identify problem areas and potential problem areas. Each should be evaluated by priority or urgency. Life safety items, such as severely spalled masonry or loose and crumbling stone, should get top priority, followed by owner concerns and preferences, condition of building materials, and aesthetics.

- Establish budgets and schedules for:

 maintenance, routine care, and treatment of potential problem areas;
 - repair and/or replacement of priority items, problem items, and normal wear-and-tear items; and
 - replacement or rehabilitation of major envelope components, based on the evaluation of existing conditions, warranty requirements, and industry standards.

4. Create an easy-to-use inspection tool that spells out critical inspection timetables and helps avoid and diminish emergency repairs. Many building materials have a known or anticipated service life. Regular inspections can identify materials near the end of their usefulness, and allow for a planned program of repair.

5. Identify the status and location of existing warranties and expiration schedules.

6. Create a flexible planning tool that can change with building and owner needs.

7. Provide a benchmark against which to measure progress in meeting goals.



When the face of a brick, or of any other piece of masonry, falls off, the cause is almost always due to moisture within the wall. Left unrepaired, this spalling will lead to increased water penetration, creating further spalling, and finally, to complete deterioration of the bricks shown here and intrusion of water into adjacent brick and the entire wall system.

The Bottom Line

As with any business decision, cost must justify benefit. So, what are the net benefits of developing a building envelope maintenance program? A well thought-out and researched plan can: 1. Create a financial tool for planning and managing major/minor capital expenditures over any time period, whether for one, five, ten, or more years.

2. Establish a continuity of maintenance and repair information and formal documentation that will survive turnover in facility staff or changes in building ownership. The transfer of existing knowledge is always less costly than re-inventing it.

3. Create an asset for the sale of a facility by demonstrating owner commitment to the facility and by providing valuable information about the building to potential buyers and, in turn, reducing or eliminating the need for due diligence.

4. Identify areas where construction economies can be achieved. For

example, costs may be saved by scheduling repair projects to avoid duplication of access or safety measures, such as scaffolding or protective sidewalk bridging.

5. Protect the integrity of manufacturers' warranties by identifying and guiding the performance of any upkeep necessary to maintain contractual requirements.

6. Eliminate costly surprises by catching small problems before they escalate.

A Tool To Use

Planning ahead is easier said than done. All too often, day-to-day facility operations make it difficult to keep plans intact, particularly if they are not formally documented. Even worse, however, is having a building envelope maintenance program and not using it.

A good program is the one filed in a drawer, providing a one-time snapshot of current conditions and a forecast for the future. But a winning program is the one that is used as a living, working guide to all building maintenance decisions, as a measure of where you've been, and as a map of where you're going.

Ideally, the program should be used in the first year to set future budgets and identify specific maintenance, repair, and rehabilitation work for the coming year. In subsequent years, the program can continue to serve as a budget projection tool for upcoming capital expenditures. But it will also serve as a benchmark. Once a year, facility management staff should conduct a formal review of the previous year's work, asking the following questions: What work was performed? What work was delayed? What is the current status of materials or building areas that had been earlier identified as potential problem spots? Should priorities be



This is what happens when the small details of maintenance and regular inspection are overlooked. In this case, scoured and missing gravel surfacing should have been replaced to provide the necessary UV protection for the built-up roof. Blisters should have been repaired. Areas of ponded water should have been investigated to see if drains were clear or if drainage improvements were needed.

adjusted? Once these questions have been answered, the document itself should be updated to create a record for the years to come.

Where To Start

Recognizing the benefits of a building envelope maintenance program is good, but knowing how to put one in place is better. Begin by considering three key issues:

1. Where you are today? What is the current status of your facility or facilities? A qualified professional architect or engineer with expertise in exterior building rehabilitation can conduct the essential in-depth conditions survey of your facility, and formally document the findings in a written report. Photographs, as-built drawings, elevations, and other visual information that help

describe the current condition of the building envelope are all critical components of this report. 2. Where do you want to be? What are the immediate repair needs, if any? Are there life safety issues that must be immediately addressed? Once any emergency or critical conditions have been identified and addressed, priorities for any remaining repair, maintenance, or replacement work can be established based on budget considerations, schedules, and other factors. 3. Finally, how will you reach those goals? With a building envelope maintenance program, you'll have the answer to that well in hand. ■

The Hot Spots

K nowing the roof's "hot spots" the places where deterioration typically occurs — can help reduce the number of emergency roof repairs a building may need. The best way to prevent major roofing problems is to conduct visual inspections every six months and make all needed repairs, large or small, as soon as possible. Put these trouble spots — described below and highlighted in red on the building isometric shown here — at the top of your regular inspection checklist:

• Ponded water (A) — puddles that stay on the roof for more than two days after a rainfall — provides a constant source of water for potential leaks in the field membrane.

• Parapets (B), copings (C), and expansion joints (I) are a major source of leaks. For example, water that gets into the parapet can enter the roof system below the terminations and flashing, and enter the building through points below the roof.

• Bent or loose counterflashing (D) can open the way for water entry into the walls and roof flashings.

• Roof penetrations are prime candidates for water entry and resulting deterioration of the roofing system. The vent (E), vent pipes (F), penetration pocket (G), roof hatch (H), rooftop equipment (J), equipment supports (K), fan unit (L), fan hood (M), pipe supports (R), antenna (S), ladder (T), and hot stack (U) are examples of danger spots.

• Gutters, downspouts, and drains (O, P, and Q) should be kept clean and free of debris to maintain good drainage and eliminate standing water.

• Walkway pads (N) should be present to prevent damage to the roof membrane from foot traffic. ■

Illustration Key

- A. Ponded water
- B. Parapet
- C. Coping
- D. Base flashing/counterflashing
- E. Vent
- F. Vent pipes (stacks)
- G. Penetration pocket
- H. Roof hatch
- I. Expansion joint
- J. Rooftop equipment
- K. Equipment support

- L. Fan units
- M. Fan hood
- N. Walkway pads
- O. Gutter
- P. Downspout
- Q. Drain
- R. Pipe supports
- S. Antenna
- T. Ladder
- U. Hot stack



This building isometric shows key trouble spots that should be inspected regularly to help avoid more extensive and costlier deterioration and reduce the need for emergency repairs.



REPRESENTATIVE PROJECTS

Building Envelope Maintenance Programs

Hoffmann Architects has developed building envelope maintenance and rehabilitation programs for a number of its clients. The following narratives detail the diverse plans prepared for some of these clients.

Rockefeller Center

Exterior Rehabilitation Master Plan New York, New York (Rockefeller Center Management Corporation)

How do you manage the ongoing maintenance and multi-faceted rehabilitation of a historic, 19-building, 22-acre urban complex while still meeting tenant needs and complying with the strict requirements of a city landmark preservation agency?

Hoffmann Architects developed a comprehensive master plan to help the owner, Rockefeller Center Management Corporation, do just that. The award-winning rehabilitation plan addressed facade and curtain wall restoration, roof replacements, waterproofing, and historic preservation for this National Historic Landmark, which dates to 1931. Based on the firm's in-depth evaluation of existing conditions, the plan set priorities, budgets, and schedules for each building and repair project. With assistance from Hoffmann Architects, the owner has used the plan extensively to select and manage upcoming projects, weighing costs and priorities for the various repair projects against budget considerations.



The Hartford's *Master Plan for Facade and Roof Rehabilitation* outlined the repair projects slated for each year, with a schedule for the work and roof plans and facade elevations that detailed areas of work to be performed.

The Hartford Corporate Headquarters Master Plan for Facade and Roof Rehabilitation Hartford, Connecticut (The Hartford)

Built in the 1920s, The Hartford's original granite building, with its distinctive copper dome and slate roofs, has been expanded over the years, transforming the complex into a single structure 5-1/2 times the size of its original footprint. Hoffmann Architects surveyed the structure to identify repair and rehabilitation requirements for the roofs and facades. As a result of the survey, the owner embarked on a planned restoration program with a set budget and a four-year time frame. Hoffmann Architects developed a logical progression of work that provided a detailed description of each needed repair and prioritized those repairs based on areas of greatest need.



Rockefeller Center's *Exterior Rehabilitation Master Plan* is updated annually to reflect changes in building conditions and document the previous year's repair projects.



Hoffmann Architects was asked to develop a *Restoration Master Plan* to guide the complex and painstaking restoration of the Dome of the United States Capitol.

The Dome of the United States Capitol Restoration Master Plan Washington, District of Columbia (The Architect of the Capitol)

Hoffmann Architects was commissioned by The Architect of the Capitol to develop a master plan for the restoration of the cast-iron dome of the United States Capitol, which was completed in 1863. The master plan addresses maintenance, repair, modification, and restoration work for all systems, spaces, and finishes from the floor of the Capitol Rotunda to the top of the Statue of Freedom, as well as adjacent areas. The master plan was the outgrowth of a 1991 award-winning study Hoffmann Architects conducted that investigated the causes of ongoing water infiltration problems at the dome. Since then, some repair work was initiated, based on the firm's design recommendations and contract documents. During the course of this work, however, it was discovered that adjoining spaces would be affected by the repairs and that protection for the work would have to expand into areas where no work was previously planned. To that end, the master plan helped identify and coordinate all repair work. Much

of the plan was based on pilot studies, which were conducted in order to develop a fuller picture of the nature, logistics, and costs of the repair work.

Trinity College

Masonry Condition Surveys and Rehabilitation Master Plan Hartford, Connecticut (Trinity College)

Hoffmann Architects investigated and documented brick, limestone, and brownstone masonry facade conditions at thirteen buildings on the campus, including the Gothic-style



Trinity College's *Rehabilitation Master Plan* included documentation of existing conditions, a schedule of repair based on priority and budget constraints, and associated cost estimates for each segment of the work.

chapel, the library, dining halls, lecture halls, dormitories, a laboratory building, and administrative offices. The investigation results formed the basis for Hoffmann Architect's phased, six-year rehabilitation master plan of repairs and maintenance.

New York City School Construction Authority

Exterior Building Maintenance Manual Long Island City, New York (New York City School Construction Authority)



The New York City School Construction Authority's *Exterior Building Maintenance Manual* will guide the exterior upkeep and repair at this Brooklyn, New York school and more than 1,100 others.

With more than 1,100 public schools under its purview, the New York City School Construction Authority (NYCSCA) needed a manageable process for maintaining the building envelopes at these facilities. Hoffmann Architects is currently developing an exterior building maintenance manual to help maintenance and facility staff conduct periodic inspections of the building exteriors, and to help identify and correct minor problems before they become major repair expenses. The manual will address roofs. exterior masonry and curtain walls. windows, exterior doors, and sealants/ caulks, and will identify anticipated life spans for specific components and

typical trouble spots. Detailed checklists will allow staff to note any changes from past inspections, including repairs or modifications. The checklists will serve as a "call to action," identifying whether a specific problem should be immediately addressed or should be monitored and re-checked at a later date. Glossaries of building terms, illustrations or photos of typical deterioration conditions, and guidelines for determing repair priorities will make the manual an essential resource for the NYCSCA staff.

The Bank of New York 1 Wall Street

Master Plan for Exterior Restoration New York, New York



The complexity of the multiple facade rehabilitation needs at The Bank of New York prompted the creation of an in-depth master plan to guide the phased restoration work.

Faced with numerous deterioration problems at the facades and roofs of this 52-story structure, built in 1932, and its 30-story annex addition, The Bank of New York commissioned Hoffmann Architects to conduct an exterior conditions survey and develop a master plan for exterior restoration. The master plan delineated a five-year phased construction program of roof and window replacement, facade and mortar repair, and facade cleaning. Some cost economies were gained by organizing the work to avoid duplication of the protective sidewalk bridging needed at various stages of the work.

JOURNAL is a publication of Hoffmann Architects, specialists in the rehabilitation of building exteriors. The firm's work includes investigative and rehabilitative architecture/ engineering services for the analysis and resolution of problems within roofs, facades, glazing, and structural systems of existing buildings, plazas/ terraces, and parking garages.

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