



4 STEPS TO A BETTER BUILDING ENCLOSURE



More than the sum of its parts, the building enclosure is a collection of integrated assemblies that work in concert to shield the interior from the elements, define the structure's aesthetic, and establish the relationship between inside and outside.

ABOUT THE AUTHORS

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LEARNING OBJECTIVES

After reading this article, you should be able to:

- + **DESCRIBE** the components and typical signs of distress and failure in building envelope elements: foundation, façade, fenestration, and roof.
- + **EXPLAIN** factors to consider when establishing rehabilitation priorities, including maintaining safety, protecting vulnerable spaces, and improving performance.
- + **APPLY** practical considerations for logistics, code requirements, functionality, and phasing to developing a budget for rehabilitation work.
- + **ADAPT** principles for prioritizing building envelope repairs to the treatment of historic and landmark structures.

Dividing the outside environment from the interior, the building enclosure is one of the most important parts of the structure. The enclosure not only defines the building's aesthetic, but also protects occupants from the elements and facilitates a comfortable, controlled climate. With dozens of components comprising the exterior assemblies, from foundation to cladding to roof, figuring out which concerns to address first can be daunting.

As interconnected systems, building enclosure elements work synergistically, which means that superior performance in one assembly helps others function at their peak; conversely, sub-par functionality in any component adversely impacts interdependent systems. Just as a roof leak can migrate and cause mold and decay in wall assemblies, cracked and bowed façades place strain on connections and roofs. Once the building enclosure is compromised, interior spaces suffer, with moisture, heat gain, drafts, noise, and glare vying to make the distinction between inside and outside more permeable than occupants would wish.

With data about building conditions in hand, project teams are faced with the challenge of establishing a budget and timeframe for upgrades and repairs. How to know which concerns demand immediate attention, and which can be deferred? Factors such as how long the owner plans to keep the property and which upgrades will be most desirable to building users are important to consider. With the guidance of an architect or engineer with expertise in building enclosure systems, property managers and owners can better determine which repairs are critical to maintain public safety, which are necessary to meet code requirements, and which, if put off, will lead to larger, more costly repairs before long.

STEP 1: EVALUATE BUILDING ENCLOSURE REPAIR DEMANDS

While routine maintenance by facility professionals is essential to the proper functioning of the building enclosure, periodic evaluation by a qualified design professional is also a must. The ability to prioritize repair needs depends on accurately cataloging deficiencies, the full extent of which may not be apparent to the untrained eye. Some problems, too, are simply not visible at the surface and require exploratory probes, laboratory analysis, and/or structural calculations to accurately assess the extent of the issue.

Foundation

The foundation is usually composed of cast concrete and rebar, concrete masonry unit (CMU) blocks, or rubble. Impervious membranes provide waterproofing for below-grade substrates and are applied to the positive side (exterior) or negative side (interior). Drainage composites and sloped grade direct water away from the building.

When foundation waterproofing systems fail, evidence of moisture, such as leaks, damp surfaces, discoloration, and corrosion of embedded rebar, indicate the need for repairs. Prolonged moisture exposure can lead to efflorescence and cracks, eventually compromising structural integrity. As capillary action drives moisture up into the exterior wall assembly, it can lead to systemic water damage.

Façade

The building skin can be made up of many different materials, each presenting its own set of common problems. Failures in masonry can be seen as cracks in mortar and masonry units, spalls (where portions of the material face break



off), bowing, displacement, efflorescence, vegetative growth, and other unsightly deterioration. For glazed curtain walls, bent mullions, loose gaskets and seals, condensation, and corrosion may evince aging and wear. Other wall systems show problems characteristic of the materials, from hysteresis (bending) in thin marble to oil-canning (dents and bulges) in metal panels.

In cavity wall systems, where a veneer is tied to a back-up structural wall, the combination of multiple materials in a single assembly necessitates accommodating for differential movement. A brick veneer will expand over time as the fired clay absorbs moisture from the atmosphere, while the CMU back-up wall to which it is anchored will shrink as the concrete dries. To allow for this natural material movement, expansion joints and relieving angles should be placed at regular intervals along each exterior wall. Failure to do so will result in an insecure wall system that poses a danger to the public.

Moisture trapped within façade assemblies is another notorious source of premature deterioration and failure. Unknowingly, many a well-meaning maintenance staffer has sealed over weep holes deliberately left in cavity wall veneers to allow trapped moisture to drain from within the assembly. Without these openings, water builds up inside the wall, causing deterioration. Continuous air and vapor barriers applied to the back-up structural wall prevent moisture that does accumulate from migrating into the building interior. Signs that such barriers are damaged, missing, or non-continuous include leaks, moisture at window and door openings, condensation, and mold/mildew growth.



Positive-side foundation waterproofing (left) is exterior; negative-side (right) is at the interior.

Fenestration

Detection of failures in doors and windows early is key. Moisture spotted after heavy storms should be addressed right away to prevent further damage. Fenestration failures not only admit moisture into the wall assembly and building interior, but also decrease energy efficiency by allowing conditioned air to escape. A common cause of failure is deteriorated sealant surrounding the openings. Another frequently encountered problem is condensation, which may be a sign that the thermal performance of the glazing unit is not sufficient for the conditioned space, or that the glazing seals have failed.

Roofs

Roof failures can happen gradually over time, or they can happen almost instantaneously during a large weather event. If failures are not addressed immediately, these leaks can continue to progress, causing more damage to the roof and building. A leak from one small area can cause extensive damage throughout the roofing system if neglected. The longer the water is allowed to travel beneath the membrane, the more damage is done. Breaches in the membrane, open seams, loose and missing shingles, and failures at penetrations are sometimes straightforward problems that may be repaired or patched. Other issues may be more pervasive, such as a leak that saturates insulation or damages the roof deck, requiring full replacement.

To achieve lasting repairs of building enclosure components, root causes must be addressed, and these can often be determined only through professional evaluation. Such a condition investigation is therefore the prerequisite to any program

of rehabilitation or repair, and, if an extended period has elapsed since a design professional has conducted the evaluation, building owners and managers would do well to consider re-assessment before investing in a construction project to resolve persistent issues.

STEP 2: SET REHABILITATION PRIORITIES

Planning for repairs can feel overwhelming when there seems to be a never-ending to-do list. Establishing criteria to prioritize needed repairs allows project teams to budget ahead of time and prevent unexpected emergencies from quickly depleting available resources. When planning construction work, architects and engineers rely on both professional opinion of critical needs and the long- and short-term goals of the client.

Maintain Safety

When it comes to prioritizing repairs, safety always comes first. Loose stone, spalled concrete, cracked terra cotta, insecure curtain wall systems, failed glazing gaskets, and areas of displaced brick are examples of conditions that should be addressed straightaway by a design professional. To protect the public, provisional securement, such as safety netting and overhead protection, must immediately stabilize hazardous conditions until long-term solutions can be implemented. Once the temporary protection is safely in place, further investigation can seek to identify the cause of the issues.

Safety ordinances, such as New York City's Façade Inspection Safety Program (FISP), may require design professionals to report observed hazardous

conditions and undertake necessary corrective measures within an established timeframe. For example, terra cotta that shows signs of structural cracks or balcony railings that are unstable necessitate immediate reporting to the NYC Department of Buildings in the wake of fatal incidents involving catastrophic failures with these building elements.

Another safety concern is mold and organic growth. Water trapped inside a wall cavity creates an ideal environment for mold and mildew to thrive. Although often undetected by building occupants, mold can cause serious health problems if not safely abated.

Protect Vulnerable Spaces and High-Value Objects

Once life-safety concerns have been addressed, the next area of priority is typically those areas housing valuable or sensitive objects, or those spaces that are themselves of intrinsic artistic or cultural importance. For instance, leaks that might compromise a data center or rare-book library take precedence over those in a staff lounge or closet. Likewise, areas having valuable finishes or art, such as the Rotunda at the U.S. Capitol or the historic Art Deco lobby of One Wall Street in Manhattan, would take priority over less significant spaces, and immovable artwork, such as frescoes and inlaid stone, affects construction sequencing, as it must remain protected throughout the project.

Some owners opt to address deterioration in areas accessed by the public first, leaving private spaces for later phases. For example, a leak in an arena that hosts sporting events will take precedence over a leak in the athletic offices, not only because of the risk of damage to an expensive gym floor, but also because games are high-profile—and revenue-producing—events.

Improve Performance

With emissions-reduction legislation such as BERDO 2.0 in Boston or the Climate Mobilization Act in New York, improving the energy efficiency of buildings is no longer just a moral imperative—it may be a



Substitute materials, like GFRP for terra cotta, offer repair options for tough areas.

PHOTO COURTESY: HOFFMANN ARCHITECTS + ENGINEERS

legal one. For instance, some cities require new or replacement roof assemblies to incorporate “cool” membranes, vegetation, solar panels, or some combination of these. A reflective roof with added insulation improves the building’s overall efficiency, stabilizes the temperature at upper floors, and reduces the urban heat island effect. Considering energy use and emissions as part of building rehabilitation planning can save heating and cooling dollars, and it anticipates minimum performance standards that are becoming more common across America’s states and cities.

Energy isn’t the only metric project teams should consider when prioritizing repairs and upgrades, however. With climate change driving an increase in natural disasters, flooding, extreme heat and cold, and unusual weather patterns, the prudent building manager would do well to consider resilience as a key driver in rehabilitation planning. Foundation waterproofing, roof uplift resistance, window impact tolerance, cladding anchorage, and other measures of a building’s weatherability may prove critical to its ability to recover from extreme weather events. Furthermore, proactively protecting the building from the elements—and documenting these efforts—can prove critical should storm damage necessitate an insurance claim.

Beyond the basics of energy performance and resilience, the comfort of users is paramount to the day-to-day functionality of the building. Interior spaces that admit drafts, noise, glare, and heat gain are red flags that the building enclosure

is not doing its job: providing a barrier between inside and out. To create an interior environment that is conducive to productive work and good health, building owners and managers may need to prioritize upgrades such as glazing replacement, added insulation, remediation of deteriorated joints and seals, and effective thermal and air/vapor barriers.

Upgrade Aesthetics and User Experience

Prominently visible from a highway in a busy metropolitan area, one 1970s office building had begun to look timeworn, and prospective tenants had taken notice. Empty spaces and lost lease revenue urged the owner to give the property a facelift. By replacing the curtain wall with eye-catching, high-performance glazing and sleek metal trim, the façade replacement not only upgraded energy efficiency and wind resistance but also revamped the building’s image, garnering a drop in vacancy and a project award.

Particularly for buildings in high-profile areas, exterior appearance may mean the difference between a profitable property and one that costs more than it earns. For building users, a renewed exterior can mean not only pride of place, but also improved experience—with glazing, cladding, and other building enclosure components that perform as well as they look.

Reduce Future Maintenance Demands

Determining which building enclosure projects should receive top priority may also entail consideration of current and future upkeep. Maintenance staff constantly on call for window and door operability issues may find their time better spent after new hardware and frame repairs restore frustration-free functionality. Design professionals can work with building owners and managers to plan for rehabilitation and replacement based on expected lifespan and projected maintenance requirements. For example, an owner might consider incorporating a snow-melt system for an entry plaza into a planned rehabilitation, an up-front expense that may be offset by the savings in maintenance and premature replacement.

Still, rehabilitation strategies must match the short- and long-term goals of the owner. Is the property intended for quick turnaround, or will it be an enduring investment? Decisions such as whether to re-seal a curtain wall or implement a full-scale replacement will be impacted by how the longevity of those options dovetails with the intended ownership period.



PHOTO COURTESY/HOFFMANN ARCHITECTS + ENGINEERS

As maintenance is deferred, cracks and spalls proliferate into emergency hazards.

STEP 3: BUDGET FOR REPAIRS AND UPGRADES

In today’s environment, project teams face formidable challenges when trying to maximize the available budget for repairs. While uncertainties related to expenses and scheduling present hurdles, establishing a balance between conditions that require immediate attention and work that can be postponed or phased helps to provide a positive direction while affording the best opportunity for controlling overall costs.

Top Priority: Safety

Public safety and the need to remove imminent danger posed by the physical elements of a building, such as a structurally unstable parapet, have no option for delay. Costs to immediately stabilize a hazardous condition or erect the necessary site protection are a given. Loose slate shingles on aged roofs or cracked and deteriorated terra cotta on older buildings can become dislodged and fall off with little to no warning.

All-at-Once or Phased Over Time

Depending on the scale of the project and nature of the repairs or renovation planned, there may be an opportunity to sequence the work in phases. On large projects, though, project teams may realize an overall cost savings by getting everything done at once. Particularly with older buildings, repairs can build on one another as more concealed

conditions become exposed. Performing the full program of repairs at one time saves on repeated mobilization and access costs by erecting scaffolding only once at each location.

While, ideally, it may be more practical and cost-effective to complete a large project with a single approach, incurring the total cost all upfront may make it harder to get a larger budget approved. Separating the work into phases not only can make funding easier to obtain, but also allows the project team to focus on one priority at a time. However, stretching a project over a longer period may be more disruptive to occupants and can result in a higher overall cost.

Form vs. Function

Aside from critical repairs, owners may desire to change the aesthetics of the building or make code improvements to increase the value of the property. Budgeting design changes for replacement of an existing component is often done with a more planned approach and favorable timeframe.

Visual upgrades frequently don't require the urgency of less noticeable functional repairs. Major capital improvement projects, such as replacing an outdated curtain wall assembly, routinely take longer to fully fund and obtain the required approvals than do operational improvements to existing systems.

New Code Requirements

At times, project teams are faced with the need to make code-compliance improvements either

mandated by local jurisdictions or on a more voluntary basis. When preparing a budget for this type of work, design considerations and appropriate options must be explored. In-kind replacement of a particular building element may not be possible. Project teams wishing to go beyond code minimums may not be able to achieve their desired goals because of physical constraints posed by the existing structure or limitations of remaining systems and materials.

Modifying a component of an existing building to meet current code standards isn't always possible without performing additional costly work first. Adding insulation in a reroofing project to meet present code may require raising door thresholds or surrounding parapet counterflashings to enable proper clearances for the taller finished roof surface. Similarly, 60-year-old single-glazed windows with non-thermally-broken aluminum frames cannot, in most cases, be made to meet current code requirements simply by adding storm windows to the exterior or interior.

STEP 4: ANTICIPATE FUTURE NEEDS

Design professionals should provide guidance as to the expected lifespan of a restoration or new assembly. Investing in quality materials with proven durability may cost more up front, but it will likely save money and headaches down the line. Still, nothing lasts forever, so documentation of anticipated longevity and warranty periods is vital for setting up a long-term budget plan. Some materials

Special considerations for landmark structures

Projects involving work to landmark structures or buildings on the National Register of Historic Places require extra care in planning and budgeting.

Knowledgeable professionals familiar with the pertinent requirements and formal review process for the treatment of historic buildings can assist owners in navigating the State Historic Preservation Office (SHPO) and other authorities having jurisdiction (AHJ) for approvals.

Designs for alterations to designated buildings typically must be performed in conformance with the Secretary of the Interior's Standards

for the Treatment of Historic Properties, as applicable to the project type and intended materials. With criteria for classification as renovation, rehabilitation, restoration, or reconstruction, the Standards presents guidelines of "dos" and "don'ts" for each approach. Practices for the respectful treatment of specific building materials related to each type of project further constrain available repair options.

Approval for work to landmark or historic structures must first be obtained from local and/or federal oversight agencies before permitting from the department of buildings for

that jurisdiction. Required documentation for the proposed project may include measured drawings, photographs, field records, and written data specifically designed to address historic significance.

Although treatment to buildings with historic designations may follow a stringent set of guidelines that doesn't pertain to newer structures, these older buildings typically are not exempt from current accessibility and life safety codes. The challenge is to meet applicable code requirements while minimally impacting – and preserving – defining features and spaces.

Make sure to include parking garages in the plan

In June 2021, the partial collapse of Champlain Towers South in Surfside, Florida drew the nation's attention to the perils of deferred maintenance and structural deterioration in garages, particularly those integrated within an occupied building.

Persistent water penetration, corrosion of reinforcing steel, and deficiencies in the original construction combined to cause the sudden and deadly failure of the basement parking levels, precipitating the progressive collapse of tenant floors above.

In light of such catastrophic failures, more and more states and municipalities are instituting inspection and repair ordinances for parking structures. New York State enacted periodic parking garage inspection requirements in 2019, and New York City

began mandating garage inspections in January 2022. After the Surfside collapse, many building owners voluntarily initiated comprehensive assessments programs of their parking structures.

When prioritizing garage repairs, project teams would do well to approach the work with similar thinking as they might take with the building enclosure. Ensuring public safety should always be the main concern. For the remainder of the work, a pragmatic approach would be first stopping further damage and deterioration, and then considering changes to appearance and functionality.

Recognizing the physical and functional differences between building enclosures and parking garages is important when considering repair work. By their

design, unless enclosed in the basement of a building, parking garages not only face exposure to weather on the exterior, but their open construction leaves them at the mercy of the elements on the interior, too. Vehicular traffic through the structure further imposes loads and wear.

With components that tend to be more utilitarian than those of a building enclosure, garages frequently require a less invasive and complicated scope of work when repairs are needed. Parking structures are often constructed primarily of concrete and, with routine maintenance, tend to have greater longevity than building enclosures. As the tragedy at Surfside underscored, however, that upkeep is key, along with oversight to see that construction adheres to specifications.

and assemblies offer 20- or 30-plus-year warranties. It is important to choose wisely.

Costly unexpected repairs can pose major financial burdens, so staying on top of maintenance is key. A design professional should conduct periodic reviews of the building to catch problems early before they evolve into disruptive and costly repair projects. For newly restored or replaced components, maintenance staff should have training in appropriate ways to clean, treat, and repair areas based on the materials used. Certain chemical cleaners or abrasive methods can erode surfaces, limiting lifespan.

Keeping up with new technologies is important. Product innovations are constantly introduced into the market, and a building can quickly become dated by not incorporating the latest trends. Whether paint with insulating value or concrete pavers derived from fungi, advances in material technology offer exciting possibilities for sustainability and performance. To stay relevant without overspending, building owners and managers should seek the advice of design professionals as to which offerings are worth the money and which may be a passing fad.+