Prioritizing Your Building Enclosure Needs

By Russell M. Sanders and Kelsey R. Greenleaf

Building enclosures are one of the most important parts of a structure, dividing outside environments from interiors. An enclosure not only defines a building's aesthetic, but also protects occupants from the elements and facilitates a comfortable, controlled climate.

With dozens of components comprising exterior assemblies—from foundation to cladding to roof—figuring out which concerns to address first can be daunting. A facility manager faced with an exterior water feature leaking into the museum café, an aging drainage system above an exhibit space that's overloaded in heavy rain, and an entry stair that needs to be brought up to code, might well wonder which of these pressing problems should take top billing.

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

With data about building conditions in hand, building owners and managers face 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? In some jurisdictions—notably New York City, where buildings must undergo periodic façade inspections and repairs—setting priorities may be a matter of complying with the dictates of the law. Conditions designated "unsafe," such as loose terra cotta, must be addressed immediately, while maintenance items, such as sealant replacement or brick repointing, may be deferred until closer to the next inspection cycle.

Factors such as how long an owner plans to keep a property, and which upgrades will be most desirable to building users, are also important to consider. Sometimes, it takes a near-catastrophe to prompt swift action. When part of the curtain wall at a hospital tower detached from the structure, no one was injured, but the incident spurred the facilities team to prioritize the languishing wall system that had been near the point of failure for some time.

Guided by 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.

More than the sum of its parts, a 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.

What Is a "Building Enclosure"?

As with the sleeve for a letter, the envelope of a built structure protects the elements within and creates a boundary between "inside" and "outside." The ***foundation*** provides the structural base and serves as the border between earth and the rest of the building, while also transitioning to the ***façade***, or outer walls. Windows, doors, louvers, and other ***fenestration*** create a permeable barrier that modulates the passage of light, air, moisture, heat, sound, and the building's occupants. ***Roofs and terraces*** cap the enclosure, provide protection against weather, hold mechanical equipment, and may offer amenity space.

The points at which these components intersect are ***transition elements***, and include flashings, parapets, fascia, sills, jambs, headers, joints, and other junction materials. Transition elements allow for differential movement and continuous protection from moisture intrusion, heat loss, and other unwanted transfer between outside and inside. Within each element of the enclosure assembly there are further details, from weep holes and scuppers to expansion joints and relieving angles, which—when properly designed, calibrated, and maintained—keep the interior environment comfortable, the building systems operational, and the other components free from deterioration and wear.

Together, this compendium of assemblies—as diverse in materials and methods as there are building types—works in concert to protect the building and its occupants. When the building enclosure functions well, it is remarkable chiefly for its aesthetic qualities and architectural character. When it does not, its shortcomings may become its salient feature, not just to overwhelmed facility personnel, but also to building users and public safety.

Step 1: Evaluate Building Enclosure Repair Demands

Although routine maintenance by facility professionals is essential to the proper functioning of the building enclosure, periodic evaluation by a qualified design professional is extremely important. The ability to prioritize repairs depends on accurately cataloguing deficiencies—from failed glazing seals and mortar joint erosion to poorly configured drains and moisture-saturated insulation—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. For instance, a masonry wall may appear sound until probes reveal missing brick ties, or cracking in a concrete deck might look mild until laboratory analysis of test cores uncovers high concentrations of corrosion-inducing chlorides.

Unsafe conditions demand immediate attention.

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 a 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. At a historical downtown church, a daycare in the basement was forced to close temporarily when moisture problems became too pervasive. The only solution was to dig a trench around the building, expose the foundation walls, and restore the waterproofing.

Prolonged moisture exposure can also 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.

Slapdash repairs can make problems worse.

Façade

The building's skin can be made up of many different materials, each presenting its own set of common problems. Failures in masonry appear 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 within a single assembly necessitates accommodation 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 concrete dries.

To allow for this natural movement of materials, expansion joints and relieving angles should be placed at regular intervals along each exterior wall. Failure to do this will result in an insecure wall system that poses a danger to the public. As a cautionary tale, one exterior wall failure on which we consulted seemed to involve windows that had, mysteriously, fallen in their openings. What we found, however, was the opposite: the walls were moving up around the windows.

Exploratory probes revealed that the brick masonry veneer was anchored to CMU back-up walls without any relieving angles or expansion joints. As the brick expanded and the concrete shrank, the wall system struggled against itself, dragging the windows, along with much of the brick masonry, out of place with the force of the differential movement.

Moisture trapped within façade assemblies is another notorious source of premature deterioration and failure. Unwittingly, many well-meaning maintenance staffers have sealed over weep holes that were deliberately left in cavity-wall veneers to allow trapped moisture to drain from within the assembly. Without these openings, water builds up inside the walls, causing deterioration.

Continuous air and vapor barriers applied to the back-up structural wall prevent the moisture that does accumulate from migrating to the building interior. Signs that such barriers are damaged, missing, or non-continuous include leaks, moisture at window and door openings, condensation, and the growth of mold and mildew.

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

Left: Positive-side foundation waterproofing is applied to the exterior. Right: Negative-side waterproofing is on the interior.

Fenestration

Early detection of failures in doors and windows is key. To prevent further damage, it is important to spot moisture after heavy storms, and address the issue right away. Fenestration failures not only admit moisture into the wall assembly and building interior, but also decrease energy efficiency by allowing conditioned air to escape. Deteriorated sealant surrounding the openings often causes failure.

Condensation is another frequently encountered problem. It 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 happen gradually over time, or almost instantaneously during a large weather event. If failures are not addressed immediately, leaks can progress, causing more damage to the roof and building. If neglected, a leak in one small area can cause extensive damage throughout the roofing system. The longer the water travels 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 a roof deck, requiring full replacement.

To achieve lasting repairs, root causes must be addressed, and these are often determined through professional evaluation. Such an investigation is a prerequisite to any rehabilitation or repair. If an extended period has elapsed from the time a design professional conducted the evaluation, building owners and managers would benefit from considering re-assessment before investing in a construction project to resolve persistent issues.

Roof repairs and replacements at this sports headquarters identified sources of leaks and addressed errors in the original construction.

Step 2: Set Rehabilitation Priorities

Planning for repairs can feel overwhelming when there is a neverending to-do list. Establishing criteria to prioritize needed repairs allows facility managers and building owners to budget ahead of time, and prevent unexpected emergencies from quickly depleting available resources. When planning construction, architects and engineers rely on professional opinions of critical needs and a client's long- and short-term goals.

Here are some issues to consider when deciding which rehabilitation needs must be addressed as a matter of urgency, which may be required by code, and which, though not imperative, may still prove worthwhile.

Maintain Safety

When prioritizing repairs, safety always comes first. Loose stones, spalled concrete, cracked terra cotta, insecure curtain-wall systems, failed glazing gaskets, and areas of displaced bricks are examples of conditions to address straightaway with a design professional. To protect the public, provisional securement—such as safety netting and overhead protection—must be added immediately to stabilize hazardous conditions until long-term solutions can be implemented. Once temporary protection is safely in place, further investigation can seek to identify the issue's causes.

Safety ordinances, such as New York City's Facade 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

Stabilizing beams until permanent repairs can be made.

unstable, necessitate immediate reporting to the NYC Department of Buildings in the wake of fatal incidents involving catastrophic failures.

Mold and organic growth is another safety concern. 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

After addressing life-safety concerns, the next area of priority is typically those areas holding valuable or sensitive objects, or those spaces that are themselves of intrinsic artistic or cultural importance. For instance, leaks that compromise a data center or rare-book library take precedence over those in a staff lounge or closet.

Likewise, areas with 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. In addition, immovable works of art, such as frescoes and inlaid stone, affect construction sequencing, as these must remain protected throughout the project.

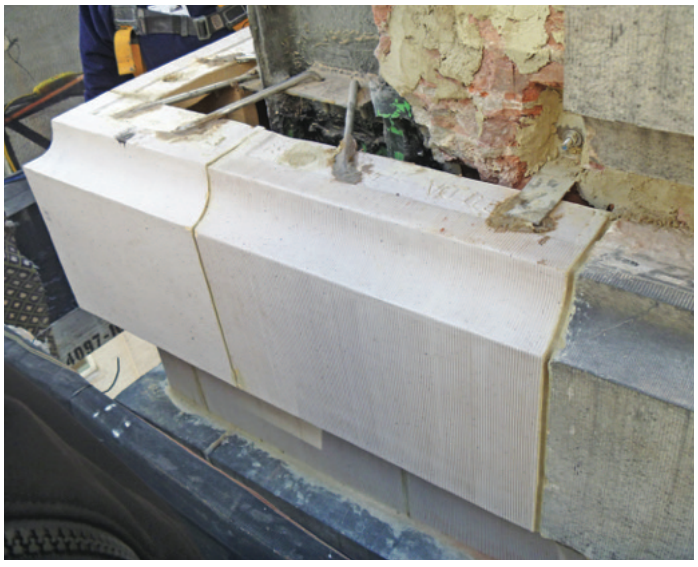
Some owners opt to address deterioration in areas accessed by the public first, leaving private spaces for later phases. For example, a leak in an arena that hosts sporting events will take precedence over a leak in the athletic offices, not only because of the risk of damage to an expensive gym floor,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

Vulnerable artifacts must be protected.

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 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 U.S. states and cities.

Energy, however, isn't the only metric building owners and facility managers should consider when prioritizing repairs and upgrades. With climate change driving an increase in natural disasters such as flooding, extreme heat and cold, and unusual weather patterns, a prudent building manager should 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 a building from the elements—and documenting these efforts—is critical if storm damage necessitates an insurance claim.


Substitute materials, such as GFRC for terra cotta, offer repair options for tough areas.

Beyond the basics of energy performance and resilience, the comfort of users is paramount to a building's day-to-day functionality. 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 conducive to productive work and good health, building owners and managers should prioritize upgrades such as glazing replacement, added insulation, remediation of deteriorated joints and seals, and effective thermal and air/vapor barriers.

Upgrade Aesthetics and the User Experience

Prominently visible from a highway in a busy metropolitan area, one 1970s office building had begun to look time-worn, and prospective tenants had taken notice. Empty spaces and lost lease revenue caused 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.

Exterior appearance may mean the difference between a profitable property and one that costs more than it earns, particularly in high-profile areas. For building users, a renewed exterior not only adds pride of place, but also an improved experience involving 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

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 present 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 on landmark or historic structures must first be obtained from local and/or federal oversight agencies before applying for permits 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 historical significance.

Although treatment of buildings with historic designation 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 affecting—and preserving—defining features and spaces.

Historical photograph of the doors to the New York Stock Exchange (NYSE) in 1904.

NYSE door design options proposed to the NYC Landmarks Preservation Commission.

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 owner's short- and long-term goals. 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 affected by how the longevity of those options dovetails with the intended ownership period.

Step 3: Budget for Repairs and Upgrades

In today's environment, building owners and property managers face a formidable challenge when trying to allocate for repairs. Although 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 also affording the best opportunity for controlling overall costs.

Top Priority: Safety

Public safety and the need to remove imminent danger posed by a building's physical elements, such as a structurally unstable parapet, cannot be delayed. 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. Even on newer buildings, faulty components, such as an insecure terrace railing, can pose a danger to unsuspecting users.

All at Once or Phased Over Time

Depending on the project's scale and the nature of the repairs or renovation planned, there may be an opportunity to

Including 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 assessment programs for their parking structures.

When prioritizing garage repairs, owners and building managers would do well to approach the work with thinking similar to what they might use for a building enclosure. Ensuring public safety should always be an owner's 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,

Temporary shoring at a deteriorated garage beam.

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, upkeep is key, along with oversight to ensure that construction adheres to specifications.

sequence the work in phases. On large projects, however, owners and property managers may realize overall cost savings by getting everything done at once. In older buildings, repairs can build upon 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, for example, 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 total costs upfront may make it harder to get a larger budget approved. Separating the work into phases not only makes funding easier to obtain, but also allows the project team to focus on one priority at a time. Still, stretching out a project over a longer period can be both costly and disruptive, requiring occupants to endure recurring deployment of construction equipment and site-protection measures, longer duration of construction noise and dust, and bothersome circumnavigation of work areas, among other inconveniences.

Form vs. Function

Aside from critical repairs, owners may want to change a building's aesthetics or make code improvements to increase the property's value. 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, owners must address code-compliance improvements, either mandated by local jurisdictions or on a more voluntary basis. When budgeting for this type of work, design considerations and appropriate options must be explored. Historical buildings, for instance, are not exempt from ADA universal access requirements, yet proposed designs for ramps, handrails, lifts, and other additions must consider the impact on the character of a building. Recently, our architects and engineers faced the challenge of updating a historical entrance plaza at an Ivy League school to improve accessibility, all while protecting a 125-year-old American Sycamore, the university's oldest tree.

In-kind replacement of a particular building element may not be possible. Owners 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 the 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. In one of the most common examples, augmenting insulation in a reroofing project to meet current code requirements may result in raising door thresholds or surrounding parapet counter-flashings to enable proper clearances for the taller finished roof surface.

Another example is replacing decades-old single-glazed windows with insulating glazing units (IGUs) that are both heavier and larger than the original windows. Modifications to the wall opening are usually required to support the replacement glazing. Still, efforts to retain low-performing windows typically prove ineffective when it comes to energy performance; single-glazed units with non-thermally-broken aluminium frames cannot, in most cases, be made to meet current code requirements simply by adding storm windows.

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 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 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 be trained to clean, treat, and repair areas, based on the materials. Certain

Roof leaks above the organ and nave of this Manhattan church threatened the sacred spaces and statuary below.

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 if it does not incorporate the latest trends. Advances in material technology—such as paint with insulating value or concrete pavers derived from fungi—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.

Achieving a building enclosure that is secure, attractive, functional, and resilient allows owners and managers to easily check off routine upkeep-related tasks. A sensible plan for repair and upgrades should accommodate the practical considerations of managing an occupied structure, while addressing building needs—from urgent issues such as safety and accessibility, to goals for energy performance and the user experience.

Design professionals and owners have long worked together to make buildings spaces of both beauty and purpose, with surroundings that have the power to inspire, facilitate, comfort, and empower. Remediating exterior conditions in a sensitive and technically proficient way is a team effort, and one that begins with collaboration to set priorities that are right for the building and situation. 🏛

Russell M. Sanders, AIA, is President of Hoffmann Architects + Engineers (www.hoffarch.com), a design firm specializing in building exteriors, with offices in New York, New Haven, and Washington, D.C. Working collaboratively with project teams and clients, he oversees the firm's building enclosure projects, delivering rehabilitation plans that balance cost-effectiveness and performance. Mr. Sanders earned his architecture degree from the Ohio State University, and is a member of the American Institute of Architects (AIA), Association for Preservation Technology (APT), and National Council of Architectural Registration Boards (NCARB). He can be reached at r.sanders@hoffarch.com.

Kelsey R. Greenleaf, Assoc. AIA, is Project Coordinator with Hoffmann Architects + Engineers. She brings enclosure projects from condition investigation to design implementation, with sensitivity to building needs and client priorities. Ms. Greenleaf holds a B.S. in Architecture from Keene State College, and is a member of the AIA, Architects Declare, the Construction Specifications Institute (CSI), NCARB, and the National Organization for Minority Architects (NOMA). She can be reached at k.greenleaf@hoffarch.com.