

IDENTIFYING BUILDING ENVELOPE PROBLEMS

BY MARK K. HOWELL

By definition, “envelope” is an encapsulating covering such as an outer shell or membrane. In simple building terms, it consists of the roof, the above-grade wall system, and the below-grade wall system. An envelope’s purpose is to provide protection from external elements, which, in building construction, means protection from moisture, air, and temperature ingress and egress.

The definition sounds simple enough, but in reality—because of the thousands of complex products and systems specified and the multiple trades involved—the probability of error is high. As complex and intricate as the building envelope seems to be, how can one determine if a building envelope is going to have or is already having problems?

Proactive Investigations

In a perfect world, potential owners would engage a professional with building envelope knowledge to inspect and determine the likely building envelope investment that might be required before purchasing a structure. Owners typically look at the roof, but rarely examine

the remaining elements of the building. With good information from an investigation, a client can make a prudent business decision prior to purchase. Armed with this information, the client can negotiate the price, decide to accept the risk while being aware of the financial needs, or walk away from the deal.

Unfortunately, proactive investigations are still rare, especially when the economy

and real estate markets are booming and deal making is fast and furious. A large majority of calls are from owners who have recently acquired structures, new property managers, new condominium board members, new church business managers, or new building engineers — each of whom has just taken over a property and found that something is leaking or falling off the building.



A masonry inspection opening

Regardless of when and from whom the call comes, what is a good way to tell if the building envelope is having or will have problems?

Obviously, a building must be seen in person, and that brings up the question: How closely does one need to look? A good starting point is covered by *ASTM E 2270, Standard Practice for Periodic Inspections of Building Façades for Unsafe Conditions*, which defines the levels of façade inspections to apply to a building. Before the creation of this standard term, definitions and methods were inconsistent throughout the industry. This standard is intended to establish a consistent minimum requirement for conducting periodic inspections of building façades to identify unsafe conditions that could cause harm to persons and property. One of the most inconsistent items was the level of proximity required to determine the access for an inspection. This standard establishes two options and defines them at the very beginning in section 3.2.9, “Levels of Façade Inspections.”

- **Option 1: general inspection** involves visual observation of façade components from distances equal to or greater than six feet, with or without magnification or remote optical devices, while
- **Option 2: detailed inspection** is the visual observation from less than six feet and tactile evaluation of façade components, including probing and nondestructive testing to observe concealed conditions of wall construction.

Typically, the decision for a general inspection is made because the detailed inspection is too expensive or would take too long, or a report is needed in a short amount of time.



Sealant applied incorrectly at the window frame to trim and from trim to J bead

A building envelope investigator’s tool kit should consist of the following: a good carry bag (i.e., a hiker’s waist pack), a tape measure, a rolling wheel, a camera, a notebook, several color pens and markers, duct tape, a voice recorder, and, most importantly, personal protection equipment, including a hard hat, safety glasses, and a pair of gloves.

The general inspection can be broken down into four basic steps:

- Initial walkabout
- Knowledge gathering
- Interior symptoms
- Exterior signs

Initial Walkabout

A basic tour of the structure and cursory visual examination should be performed as the first step in the process. Next, title three pages of notebook paper—one for the wall system, one for the roof, and one for



Interior damage at the jamb of a window

the wall system below grade. Use these pages for initial notes to start the documentation process (the camera generally is not needed until Steps 3 and 4). This step is used to get familiar with the structure so that the inspector will have a mental picture of the building, if and when he or she gets to see the drawings.

Beginning with the wall system, it is vital to walk around the structure to get an understanding of its shape and makeup,

materials used, as well as any features such as balconies, cornices, or ornamentation. Also, check to see how the building is terminated at grade. Next, continue to the roof to see the layout. If it has a parapet, note how the roof is terminated to the parapet, how the roof is accessed, and the roof system type. Finally, continue to the below-grade area of the structure to look for sump pumps, smell for dampness, and determine the foundation wall construction. Once the

brief walkabout is complete, it is important to meet with the building manager, property manager, business manager, and others to start the next step: knowledge gathering.

Knowledge Gathering

Start this step by asking for a set of drawings. Sometimes this is a challenge. Before arriving, it is best to inform the owner that drawings are going to be needed so that they can be found and organized. Hopefully, there are drawings to review, but with older structures, they may not be available. In this case, in order to access some of the history of the structure, interview management, maintenance staff, and tenants, in addition to reviewing the maintenance and project file. Also, ask for any warranties; there is typically one for the roof, but also ask for manufacturers' warranties for the window systems and the below-grade waterproofing system.

Flip to sections with details on the wall systems. First, try to identify the wall system as a barrier wall or a water-managed wall. (See ASTM E 2128, *Standard Guide for Evaluating Water Leakage of Building Walls*.) Barrier wall is defined as the mechanism intended to prevent leakage in this type of wall by blocking or interrupting the movement of water to the interior. A water-managed wall is the mechanism intended to prevent leakage by controlling and discharging anticipated and accepted amounts of water that penetrate the exterior surfaces. If it is unclear or seems to be questionable, be suspicious of the design details. Next, check the details. If insufficient details are pulled out of the wall sections to show how to create terminations, penetrations, and changes of plane for all of the particular wall-system building materials, it immediately throws up a red flag.

Unless the project had a high level of quality field craftsmen or really good inspectors, there may be some challenges in the way field decisions were made in order to make these details work. Also, shop drawings should be part of the requested drawings, especially for the windows if there is a curtain wall. From the window shop drawings, try to determine how the window system is managing water. A lack of wall details or a lack of shop drawings at any time makes Step 3, Interior Symptoms, more intense.

For the roof, always look at the system type and check if the construction drawings of the roofing system match the existing conditions. If they don't, has there been any

modification or repair? Also, if there has been a modification, what, if anything, has been done to the parapet wall? Because parapets are exposed to weather on three sides, there is a greater chance of their having problems, especially if the modifications did not take into consideration the original design intent. Identify the number of drains and whether there is an appropriate roof slope-to-drain. How the through-wall scuppers are detailed always should be reviewed, especially if the scupper outlet is directly at the vertical expansion joint. Finally, locate the system specified for the below-grade waterproofing and see if any details were made on termination, penetration, and changes in plane.

Interior Symptoms

At this point, if the building management has any knowledge of interior water infiltration, severe cracking of interior finishes, or both, now is the time to take the observations gathered in Steps 1 and 2 to identify symptoms in the interior. Look for the



Exterior signs of brick spalling



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Roof run up the back of a parapet wall that created damage to the terra cotta cornice.

following symptoms:

- Staining of the interior wall surfaces, the wall system above the ceiling tiles, or both
- Water-damaged insulation above the ceiling tiles
- Stained ceiling finishes
- Water-damaged window soffits, jambs, and sills
- Water stains on the floor finishes, including rust stains from excessively wet steel-stud baseplates
- Peeling of wallpaper
- Cracking of interior finishes
- Stains/dirt in operable window tracks
- Water stains at the perimeter of the AC units
- Mold
- Odors

Document the location of these interior symptoms so that during Step 4, Exterior Signs, a determination can be made as to whether or not there is a direct correlation. With regard to water infiltration, remember that water does travel. As such, symptoms are often not simply on the exterior of the building. Here is where *ASTM E 2128, Standard Guide for Evaluating Water Leakage of Building Walls*, is a tremendous resource.

Exterior Signs

Once information has been gathered from the previous three steps, the inspector will have a better understanding of what to focus on during the review of the exterior signs. For walls, the obvious big three are bulging, spalling, and cracking. Following is a brief list of other exterior signs to consider:

- The wall system has a cavity but the flashing cannot be seen. Even if drawings and inspection indicate a flashing, if it cannot be seen in the field by the naked eye, the installation and/or functionality is suspect.
- Weep holes are caulked or mortared shut.
- Weep tubes or weep wicks were used.
- The roof extends up the back of the parapet wall.
- Rust marks are present at embedded steel locations.
- Railing posts are set in concrete pockets.
- Cracks go through both the masonry and the mortar.



- Capstones have craze cracking.
- Capstones have inside and outside bed joints and the cross joints are caulked shut.
- Brick is spalling.
- Glazed brick is spattered with efflorescence stains.
- Cracking exists through EIFS lamina.
- Post-tensioning ends with rust bleed-out.
- A white haze is seen on brick cavity wall.
- Efflorescence appears from cracks in concrete or masonry.
- Grade is sloped toward the building.
- Rainwater conductors cut off and run out on grade.
- Horizontal rust lines appear in mortar joints.
- There is discolored stone or masonry.
- Windows and doors are racked.
- Door and window frames are rotted or rusted.
- There are signs of condensation on glass.
- Excessive mortar joint popping is seen.



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- Caulking is smeared on mortar joints.
- There is step cracking off steel lintels.
- Carpets are glued down on exterior horizontal concrete surfaces
- Terra cotta is painted and/or caulked.
- Glass-to-metal glazing has turned into gum or has shrunk from the window frame.
- Building sealant is compressed at expansion joints
- Curtain walls or window systems are face-sealed.
- Surface alligating of the roof membrane is apparent.
- Roof seam is split.
- There is a roof surface-applied termination bar to a cavity wall.
- Overall roof drainage is poor.
- Expansion joints are incomplete.

If any of these signs match with any symptoms identified in the previous steps,

there is a very good chance that the building envelope faces some challenges. The exterior signs without interior symptoms do not mean there is not a challenge, but it's just a matter of time. In most cases, the interior symptoms will occur at some point in the life of the structure, so it is important to continue monitoring these conditions.

In most cases, obvious building envelope problems are easy to identify. In order to identify the not-so-obvious signs (especially if the interior symptoms have not occurred or have not been identified), experience in the repair of building envelope deficiencies is priceless. Combine this with the knowledge of architectural details, engineering basics, good waterproofing practices, as well as an inspection plan as outlined above, and the owner will have the best possible information about the building envelope. This information can be used as a tool to purchase a building, create capital projects, or develop a maintenance plan. 

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