



# 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, 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 chance of error is high. As complex and intricate as the building envelope seems to be, how can you tell if a building envelope is going to have or is already having problems?

## Proactive Investigations

In a perfect world before clients purchased a structure, they would engage a professional with building envelope knowledge to inspect the structure and determine the potential building envelope investment that may be required. Clients typically look at the roof, but rarely go into the remaining elements of the building envelope. With good information from an investigation, a client can make a prudent business

decision prior to purchasing a structure. Armed with this information, he can renegotiate the price, 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 clients 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. Regardless of when and whom you get the call from, what is a good way to tell if the building envelope will have problems?

Obviously you have to see the building in person, which then brings up the question: How closely do you need to look? A good starting point is covered by the *ASTM E2270 Standard Practice for Periodic Inspections of Building Facades for Unsafe Conditions*, which defines the levels of façade inspections to apply to a building. These definitions can be adapted and applied to the building envelope. The ASTM guidelines define a general inspection as observation from greater than six feet and detailed inspections as a visual observation from less than six feet. Typically, the decision for a general inspection has been made because the detailed inspection is too expensive, would take too long, or a report is needed in a short amount of time.

So, we arm ourselves with a building envelope investigator’s tool kit, including but not limited to: a good carry bag (I use a hiker’s waist pack), a tape measure, rolling wheel, camera, notebook, several color pens, markers, duct tape, a voice recorder and, most important, 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 Walk About
- Knowledge Gathering
- Interior Symptoms
- Exterior Signs

## Initial Walk About

I like to begin with a basic tour of the structure before I really get into the details of the next three steps. I title three pages of my notebook at the top—one for the wall system, one for the roof and one for the wall system below grade. I use these pages as my initial note pages to start the documentation process and usually skip using the camera until I get into Steps 3 and 4. This step is used to get familiar with the structure so that if and when I get to see the drawings, I have a mental picture of the building.

Beginning with the wall system, I walk around the structure to get an understanding of the shape and makeup of the structure, materials used, as well as any features like balconies, cornices or ornamentation. Also, I check to see how the building is terminated at grade. I then head to the roof to see the layout—if it has a parapet, how the roof is terminated to the parapet, how the roof is accessed, and the roof system type. Finally, I head

Water-damaged window soffits, jambes and sills.



to the below grade area of the structure, looking for sump pumps, smelling for dampness and determining the foundation wall construction. Once I have made this brief walk about, I go to the building manager, property manager, business manager, etc., to start the next step: Knowledge Gathering.

### Knowledge Gathering

I start this step by asking for a set of drawings. Sometimes this is a challenge. I usually let them know I am going to need these before showing up so they can find them, organize them, unbury them, etc. It is hoped, they have drawings to review; but with older structures these may not be available. In this case, in order to access some of the history of the structure, you interview management, maintenance staff and tenants, in addition to reviewing the maintenance and project file. Also, ask for any warranties; usually you get one for the roof but also ask for manufacturer warranties for the window systems and the below-grade waterproofing system.

Being more comfortable with facades, I usually flip to sections to find details (or the lack thereof) on the wall systems. First and foremost, I try to identify the wall system as a barrier wall or a water-managed wall (see **ASTM 2128 Standard Guide for Evaluating Water Leakage of Building Walls**). If it's not clear or if it seems to be questionable, that jump-starts my suspicions on the design details. Next, I check out the details. If a lack of 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 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, part of the drawings asked for are the shop 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 the lack of shop drawings at any time makes Step 3, Interior Symptoms, more intense.

For the roof, I always look at the roofing 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? 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 them having problems, especially if the modifications did not take into consideration the ordinal 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. Last, I try to 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 and/or severe cracking of interior finishes, now is the time to take the observations you gathered in Step 1 and Step 2 in order to identify symptoms

in the interior. A brief list of symptoms to look for is:

- Staining of the interior wall surfaces and/or the wall system above the ceiling tiles (Figure 1)
- Water-damaged insulation above the ceiling tiles
- Stained ceiling finishes
- Water-damaged window soffits, jambes and sills (Figure 2)
- Water stains on the floor finishes, including rust stains from excessively wet steel stud base plates
- Peeling of wallpaper
- Cracking of interior finishes
- Stains / dirt in operable window tracks
- Water stains at the perimeter of the AC units
- Mold

Document the location of these interior symptoms so that during Step 4, Exterior Signs, you can potentially see if there is a direct correlation. Specifically regarding water infiltration, water does travel; and many times, symptoms are not simply on the exterior of the building. Here is where *ASTM 2128 Standard Guide for Evaluating Water Leakage of Building Walls* is a tremendous resource.

### Exterior Signs

Once you have gathered the information from the previous three steps, you will have a better understanding of what to focus on during the inspection of the exterior signs. The obvious big **three** are bulging, spalling and cracking. Other than the obvious, here is a brief list of other exterior signs to look for:

- When the wall system has a cavity wall but you cannot see the flashing



- Weep holes are caulked shut
- Weep tubes or weep wicks were used
- The roof runs up the back of the parapet wall (Figure 3)
- Rust marks are present at imbedded steel locations
- Railing posts are set in concrete pockets
- Cracks go through the masonry and the mortar
- Capstones have craze cracking
- Capstones have inside and outside bed joints and the cross joints caulked shut
- Spalling brick
- Glazed brick shattered with efflorescence stains
- Cracking through EIFS lamina (Figure 4)
- Post-tensioning ends with rust bleed out
- A white haze on a brick cavity wall
- Efflorescence from cracks in concrete or masonry
- Grade is sloped toward the building
- Rain water conductors cut off and run out on grade
- Horizontal rust limes in mortar joints
- Discolored stone or masonry
- Racked windows and doors
- Rotted or rusted door and window frames
- Signs of condensation on glass
- Excessive mortar joint popping
- Smear caulking on mortar joints
- Step cracking off of steel lintels
- Glued down carpets on exterior horizontal concrete surfaces
- Painted and/or caulked terra cotta
- Glass-to-metal glazing has turned into gum or has shrunk from the window frame
- Compressed building sealant at expansion joints
- Face-sealed curtain walls or window systems
- Surface alligatoring of the roof membrane
- Roof seam splits
- Roof surface applied termination bar to a cavity wall (Figure 5)
- Overall roof drainage
- Incomplete expansion joints (Figure 6)

If any of these signs match up with any symptoms determined 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 symptom will occur at some point in the life of the structure, so it is important to continue to monitor these conditions.

In most cases, the 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 restoration 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 client will have the best possible information about the building envelope. This information can be used as a tool to purchase a building, create capitol projects or develop a maintenance plan.

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An illustration of a roof that runs up the back of a parapet wall.



Cracking through EIFS lamina.



Cavity wall with roof surface-applied termination bar.



Incomplete Expansion Joints