Mold on Fiberglass-Faced Exterior Gypsum Board

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This article is a case study discussion of an Indoor Environmental Technologies (IET) project in process. This project has been unusual, particularly as we discovered extensive mold growth on fiberglass-faced exterior gypsum board sheathing, a material not normally considered likely to support mold growth.

The building is a large five-story dormitory complex at a university in the southeastern USA. Basic construction is heavy steel frame. Exterior walls are filled with light steel framing, fiberglass-faced gypsum board sheathing and a traditional three-coat stucco exterior finish. The complex was built in 2004.

Moisture intrusion problems through exterior walls were first noticed in the spring of 2008 and became steadily worse. There was a delay of several years after construction before moisture issues became apparent. This is probably due to two main factors:

- It took time for moisture intrusion pathways to develop.
- The area was in severe drought for several years during this period. Less rain running down the exterior walls meant comparatively little moisture intrusion until the drought ended in 2008.

IET was part of a multi-disciplinary team (forensic architect, stucco expert, indoor environmental professional, etc.) investigating moisture intrusion issues during the fall of 2008. Numerous construction issues contributed to moisture intrusion:

- Architectural plans specified a building wrap drain plane between the gypsum board sheathing and the stucco. When the structure was built, this component was not installed.
- Because there was no drain plane or "bond break" behind the stucco, it bonded directly to the gypsum board. As the gypsum board, attached to the relatively flexible steel frame, shifted, the non-flexible stucco cracked. Many sections of the envelope developed cracks about every four feet vertically, near horizontal joints in the sheathing.
- Stucco expansion joints, flashings, corners and other details were often installed incorrectly.
- Without a drain plane behind the stucco, each crack or other penetration through the stucco created a direct path into wall cavities.

Investigation found water often entered through cracks in the stucco or at other points, penetrated through joints in the sheathing, and then ran down its interior face. A U-shaped steel track at the base of the framing collected and held water. Lightweight concrete (gypcrete) used to level the floor raised the floor surface in the adjacent room 1" to 1.5" above the concrete slab, keeping water inside the wall instead of letting it run out onto the floor (see Figure 2 on page 26).

Water accumulated at corners of the center bedrooms of each apartment, where a closet on the inside corresponded with an exterior corner on the outside. The steel framing track ended at this point, so water ran out of the track onto the floor slab. Minimal ventilation in the closets contributed to mold growth. Water also ran down inside the walls from floor to floor at exterior corners, increasing the moisture load on lower floors (see Figure 1 on page 26).

Fiberglass batt insulation in the exterior wall cavities was faced on the inside with an impermeable foil. Materials on the interior side of the foil, such as the drywall, were at equilibrium with the dry air, 45% to 55% RH, inside the building. Air and materials on the wall cavity side of the foil vapor barrier equilibrated with the water standing in the track at the bottom of the wall (often over 85% RH). These materials (such as steel framing, insulation and sheathing), are non-absorptive. They provided no hygric buffer that might have allowed minor leakage to occur without excessive humidity developing (see Figure 2).

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Mold, *from page 25*

The materials in the wall cavity between the foil and the exterior wall do not provide a food source for mold growth, and are therefore considered highly mold-resistant. Moisture conditions in this case appear to have been so extreme that mold growth nevertheless occurred in fiberglass insulation and on the fiberglass face of the gypsum board sheathing. Heavy mold growth (including *Stachybotrys* and *Acremonium*) was found in numerous locations on the sheathing. We speculate a food source was provided by soils deposited on surfaces during construction and in solution in the moisture that penetrated (see Figure 3 on page 26).

Mold growth was not found on interior drywall in most of the rooms, except in the exterior corner closets where water drained out of the framing tracks. A number of units also had water damage and mold growth for reasons unrelated to the building envelope issues.

After the investigative team presented its findings to the university, decision-makers chose to install a drainable EIFS overlay on the existing wall rather than remove and replace the defective stucco installation. This approach was less costly, less disruptive, could be completed more quickly, and minimized exposure of interior materials to outside weather. To make sure repair procedures would be fully effective, it was decided to perform initial repairs on four "stacks" of five apartments each, or a total of 80 bedrooms, before proceeding with repairs to the remainder.

Remediation of interior materials, where needed, would be performed while exterior work was underway on an apartment. IET was retained to determine where interior remediation was required and to provide oversight for the remediation work. This phase of the project was particularly challenging due to a tight deadline. Units had to be rebuilt completely before students returned for the fall 2009 semester.

Three inspection ports, each about a foot square, were cut through the exterior wall drywall in each of the five rooms of each apartment unit, with appropriate precautions to prevent release of any contaminants in the cavities. Decisions about the extent of remediation required in each room were made based on visual observation of wall cavity conditions.

A protocol for each area was written, containment was erected, then demolition and detailed cleaning were performed. Removal of affected exterior sheathing was impractical, so we specified aggressive cleaning and coating with an antimicrobial encapsulant. IET provided oversight throughout remediation to ensure work was performed properly. Upon completion or remediation, we obtained air and surface samples from each area, submitting them to a third-party laboratory for analysis.

If analysis showed samples were within acceptable parameters, the area was cleared for reconstruction. If not, more remediation was done and additional samples obtained. IET used an on-site microscope to prescreen samples and minimize lab costs.

To document that exterior repairs had stopped moisture intrusion, IET installed a remote wireless temperature-humidity-moisture content sensor in an exterior wall cavity of each of the approximately 100 rooms remediated. The sensors connect wirelessly to gateways that send collected data over the internet to a central computer, where it is logged. Users can elect to have alerts sent by email whenever the parameters exceed preset limits. The system can be accessed from any computer and a variety of reports produced (see Figure 4 on page 26).

The sensor system proved the wall repairs to be highly effective at preventing moisture intrusion. The data it provided also alerted building owners to a problem of which they'd previously been unaware: defective or improperly installed windows allowing moisture intrusion even after wall repairs. This gave our client a better understanding of the nature and extent of building issues.

IET is scheduled to continue with this project as the rest of the units are repaired and remediated during 2010.

This project has provided a good example of the need to keep an open mind about causes of building problems. Successive working hypotheses were proven invalid as additional information was obtained. An indoor environmental investigator must always keep an open mind, following the evidence wherever it leads. In particular, even building materials that are highly resistant to mold growth may be capable of supporting microbial growth in extreme conditions.

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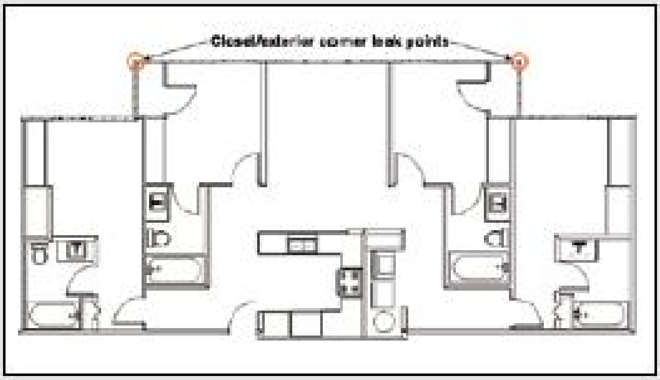

Figure 1: Typical apartment floorplan showing leak points at corners.

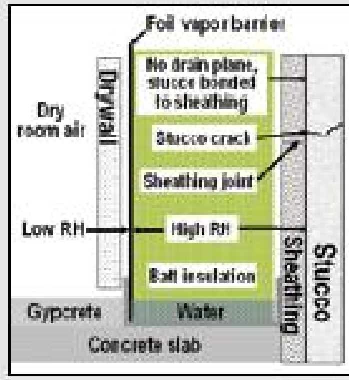

Figure 2: Diagram of cross-section through typical wall.

Figure 3: Bulk sample from visible mold growth in fiberglass-faced sheathing. Heavy Stachybotrys and Acremonium growth found.

Figure 4: Wireless sensor installed in wood block at base of exterior wall cavity.