WHEN THE BUILDING ENVELOPE FAILS

Selecting the Right Interior Finishes Can Minimize the Consequences

By Steven H. Miller

ABOVE: Thermoformed panels resist water, are cleanable without damage and do not retain moisture, so they are approved for use in places where hygiene is tightly regulated, such as over this food preparation area. Photo courtesy of Martin Knowles.

How far into the interior does the building envelope go? We design around questions of how far daylight, views and heat will penetrate, but how far will failure penetrate?

The effects of envelope performance—or failure—may extend all the way through the building, especially in regard to moisture. Although elements closest to the exterior are likely the most affected, water has a tendency of finding its way deep into a structure. Are the interior materials resilient enough to withstand intruding moisture, or will they be damaged and compound the cost and disruption caused by the envelope failure?

Intruding moisture is a frequent cause of problems with indoor air quality (IAQ). Moisture combines with organic material used in building products to create breeding grounds for mold and bacteria. Where IAQ is especially critical, such as when hospital construction mandates an Infection Control Risk Assessment (ICRA), industrial hygienists may be required on the construction site to spot weaknesses where moisture has a potential to intrude or collect.

Moisture-related damage can be minimized if potential envelope failures are considered when selecting interior finishes. This proactive design guideline is not always heeded, however.

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A dramatic example is a church in Texas, that had to replace their ceiling panels up to six times in just 30 years due to persistent roof problems.

Leaks can be caused by:

- Roofing and cladding failures,
- Voids in wall air barriers, dampproofing, and waterproofing,
- Blockages in drainage media or cavities in walls, and
- Defective flashings and sealant failures.

In addition, dripping water due to condensation can occur wherever cold surfaces contact warm, moist interior air. This occurs, for example, at thermal short circuits through insulation, glazing that does not have thermal breaks, and pipes, ducts and other objects that penetrate the envelope.

The composition of various other panels usually includes starch and cellulose, which are water absorbent and can feed the growth of mold and fungus, as well as other water-absorbent components such as expanded perlite. Visible stains and blotches in ceiling tiles may indicate bacteria and mold growth, which can impact IAQ. The U.S. Environmental Protection Agency (EPA), in *Indoor Air Facts No. 4 (revised)—Sick Building Syndrome* (Publication MD-56) lists "replacement of water-stained ceiling tile" as an example of "pollutant source removal" to reduce IAQ problems.

The Federal Emergency Management Agency (FEMA), *Technical Bulletin 2—Flood Damage-Resistant Materials Requirement* classifies common finish materials by their flood-damage resistance on a scale of 1-5, with 5 being the most resistant and 1 being the least.

A More Robust Alternative

Try as we may, most buildings will experience some form of building envelope failure during their life. An awareness of this justifies using ceiling materials that are more robust—capable of performing without failure under a wide range of conditions.

Thermoformed acoustic ceiling panels, for example, are made of rigid vinyl that is impervious to moisture and does not support growth of mold or bacteria. They comply with FEMA Category 4 for flood-damage resistance, "these materials can survive wetting and drying and may be successfully cleaned after a flood to render them free of most harmful pollutants." They can be washed with soap and water—a process that would destroy some other panels—and are therefore approved for

When envelope failures occur, interior materials need to be resilient, to avoid compounding the damage. Some ceiling panels bear evidence of the frequency of roof leaks and condensation, and can become sources of IAQ problems as well as visual blemishes. Photo courtesy of Ceilume.

Thermoformed panels have the ability to be used for creating back-lighted luminous ceilings. Photo courtesy of Martin Knowles.

Thermoformed ceiling panels made of rigid vinyl are a robust alternative. They are impermeable to water, stain resistant and fully washable. Photo courtesy of Ryan Bent.

use in places where hygiene is tightly regulated (such as healthcare and food processing facilities).

Recent testing confirms the robust properties of thermoformed panels. ASTM D1308—*Strength Properties of Prefabricated Architectural Acoustical Tile or Lay-in Ceiling Panels* evaluates four criteria, 1) Hardness, 2) Friability, 3) Sag due to humidity exposure, and 4) Transverse Strength.

Thermoformed panels also have various attributes, such as the ability to be used as drop-out panels installed beneath fire sprinklers, and light transmitting versions for creating back-lighted luminous ceilings. Thermoformed panels are stain resistant, acoustical, and up to 80 percent lighter than other panels—so they can easily be substituted in most 2 feet by 2 feet and 2 feet by 4 feet suspended ceiling grids.

With a cost-competitive, higher-performing alternative available, the persistent use of other ceilings suggests that designers are not factoring in the probability of even minor envelope failure, nor are they designing for it. Paying attention to a properly detailed envelope that can protect the interior from the outside world is paramount, but even with our best efforts, nothing is perfect. The use of robust materials that can survive a failure is also worthy of consideration. **BE**

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