Ten Common Fallacies of Making Durable Buildings.

By Jonathan Leavitt AIA

Not all building owners want the same degree of durability from their buildings. Educational institutions have a greater interest in durability than most commercial investors, if only because donors are more interested in giving money for building buildings than for maintaining them. Also, maintenance projects interfere with campus operations. The fewer big maintenance projects, the better.

To make buildings more durable than what the construction industry normally delivers can be a trying assignment. In our own practice, when we ask for details, product modifications, or even background information to help us understand the long-term behavior of a product, we often run into objections. After a few years, we start to see the same objections over and over again. Here is a list of our favorites:

1) Don't Worry; It Comes with a Warranty:

The Warranty Fallacy appears in many guises. One form applies to roofs, curtainwalls, and other large-scale systems assembled in the field. It goes something like this: The manufacturer or installer will not or cannot make design changes in the system, even if the change is an improvement, because they are providing a warranty. They do not have to submit to quality monitoring in the field, because they are providing a warranty.

The problem is that many conditions that cause chronic leakage are not really covered by warranty. For example, if perimeter flashings through rising brick walls terminate in a reglet, then water weeping through the masonry will accumulate under the roof deck and destroy the roof. This is masonry wall leakage, not roof leakage; it will not be covered by the warranty. If there is movement between the roof deck and the parapet walls that tears the membrane, it will not be covered by the warranty. With or without a warranty, it's the designer's job to create a proper roof design and address all the perimeter conditions.

A second issue involves material warranties such as the 20-year warranty on fluoropolymer-finishes (commonly used on aluminum windows) or the 10-year warranty on insulated glass units. The reasoning runs as follows: if the manufacturer will stand behind a material for ten years, then it is probably a very durable product that will last much longer than ten years.

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The fallacy here is that many materials deteriorate according to a predictable, linear schedule. Some materials really will start to fail after the specified period of time. Do you really intend to replace all the insulating glass units in a building, or replace all the pre-finished aluminum, at ten or twenty-year intervals? It's not a bad idea to consider using materials that take on a desirable patina as they age, but don't come with a warranty.

Guarantees are important enough that we address them in more detail in a separate paper, *The Use and Abuse of Warranties.* Take advantage of warranties that manufacturers offer. But design the building and monitor construction as though the quality of the finished product were your only recourse.

2) If You're Not Sure It's Going to Work, Do a Field Mock-Up and Water Test:

When the design includes an unusual architectural feature (such as the sawtooth-profile skylights at the Air and Space Museum, for example) then it's good practice to require a trial installation before proceeding with construction, is it not?

Yes it is, but the mock-up and water test have to be done far enough in advance, to allow time to change the design. What will you do if a special window assembly fails the water test, but the

windows have already been fabricated and are sitting in the factory waiting to be delivered? Even if the windows can be changed, there will be a delay in the schedule. And the window contractor, for understandable reasons, may not quote the lowest price for the changes, either.

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If a mock-up and water testing are needed, do them during the design phase. If you wait until after the project goes out to bid, it may be too late to make the needed changes, especially if the components in question have already been fabricated. If the bid terms do not impose a financial penalty to change the design, you still need to leave time in the schedule, so that the field changes don't delay other parts of the work.

The Air and Space Museum skylight, you might have guessed, exhibited leakage problems during mock-up testing. But the skylight components had already been fabricated and there was no time in the schedule to wait for new components. Construction proceeded with the original design, plus a sealant repair that proved less than totally effective. If you go to the Air and Space Museum today you can still see water stains around the skylight.

3) **You Have to Follow Industry Standards:** The construction trades include many different industries and many different industry standards. I have seen industry standards that say it is okay to lay tile in a shower room using "green board" gypsum products as the underlayment. I have seen industry documents saying that fabric flashings are proper in masonry walls, and that galvanized steel ties are suitable for brick veneer walls. For some projects, yes. But the existence of these standards does not mean that more durable practices do not exist. Concrete block is more durable than gypsum as a substrate for tile, especially in wet environments. Fabric flashings are very problematic, and solid metal flashings are much more reliable. Stainless steel lasts longer than galvanized, no matter what the industry standard says.

Whenever possible, take notice of industry standards and work with them. But owners and architects need their own standards as well. Industry standards have inertia on their side, so it sometimes takes persistence to get something better.

4) **The Cause of Leaks is Visible:** If you're faced with a building that leaks, and you notice that weep holes have been caulked over or that masonry needs pointing, it's tempting to jump to the conclusion that unplugging the weep holes or re-pointing the masonry will solve the problem. Maybe so, but not necessarily. It's just as likely that the person who caulked over the weep holes was trying to stop leakage that was already taking place. Repointing is an expensive experiment; and many historic buildings that now need repointing, have leaked since they were new. More likely, the answer is hidden deep inside the walls.

You usually can't tell why a building is leaking without water testing and opening up the walls. It's an expensive and tedious process. When you build new buildings, keeping a close eye during construction; solve any problems you find then and there, before they get covered up.

Maintenance without Diagnosis Makes a Problem Worse . A historic Gothic-style masonry building had been leaking for years. One of the symptoms was water and mineral deposits appearing around the mortar joints. In an effort to address the problem, the owners spent maintenance money to fill the mortar joints with sealant. The sealant performed remarkably well, but it held water inside the mortar joints instead of keeping water out, thereby accelerating the deterioration of the mortar. An investigation showed that the water was entering not through the walls but through a failed roof that had actually collapsed in place, tearing the perimeter flashings.

5) **Modern-style Buildings Cannot Last as Long as Traditional Buildings:** This one's easy. If people would just design nice, ordinary buildings

we wouldn't have all these detailing and construction problems. In one sense, it's true that if college students, condominium buyers, consumers, and big corporations would flock to live and work in Quonset huts, then we in the construction industry would indeed have easy jobs – or perhaps no jobs at all.

In reality, many nice ordinary buildings from yesteryear have some of the same leakage problems, and worse, than buildings of today. It's tempting to blame the innovators and "creative" types for problems. But ordinary, boring buildings have problems too. In our own experience, the buildings with the most serious design and construction defects tend not to be architectural masterpieces.

6) **Expensive Materials Make a Building Durable:** It's tempting to equate expensive materials with good results, and inexpensive materials with failure. If you're concerned about leakage, then cover the building with lead-coated copper, an expensive material used for waterproofing applications. In reverse, sealants take a lot of blame, as do exterior insulation and finish systems, and residential-grade windows.

Many materials with useful properties are very inexpensive. One of the most effective waterproofing materials is also the cheapest: asphalt-saturated felt. It sheds water very reliably when used in wall cavities and as an underlayment for wood siding, and it costs practically nothing. Silicone sealant has an almost miraculous ability to adhere securely to clean substrates of the correct type, such as glass and aluminum. And it is definitely capable of keeping out water when the geometry of the joint is correct and where there is no route for water to bypass the sealant. Even EIFS, which has been associated with serious leakage failures, continues to be used with success over durable substrates such as concrete masonry, for which it was originally developed. And expensive materials such as copper don't do much good unless they are properly installed.

It's more accurate to say there is no such thing as a bad material, only bad uses. In fact it is very rare to find materials that are intrinsically defective and have no proper application in construction.

"Know the properties of your materials, and use them in places where those properties work to your advantage."

Every once in a while one finds a truckload of lumber with incipient rot that is not visually apparent, or self-tapping screws that fracture spontaneously. But almost always, the true cause of deterioration is the misapplication of materials in configurations where they cannot perform properly. If you use wood on an exterior application where it gets wet, cover it with a flashing, or expect it to need frequent painting and re-painting, or expect it to rot.

The message should be: Know the properties of your materials, and use them in places where those properties work to your advantage.

The best materials? The first person generally credited with practicing architecture as a professional was Leon Battista Alberti, a gentleman of Florence during the Renaissance. In his *Ten Books on Architecture*, he begins the discussion of construction materials by saying that "The business of the experienced workman is not to demand the best possible materials, but rather to make sensible and appropriate use of those available; this then shall be the basis of our discussion." (Book III, Chapter 10)

7) **We've been making this product for years and we never have any problems**: The track record of a product is important. So an alert owner or designers would certainly be interested in knowing that a product has a successful track record. But it's harder than most people think to establish what the relevant track record actually is.

Sealants are a good example. There are frequent conditions where improper reliance on sealants has caused buildings to leak, and yet sealants have important and useful function. What it their track record? Lousy, in situations where they cannot perform as intended, and excellent, in situations where they can. Concealed materials such as

below-grade waterproofing are another example. Troweled-on mastic is often used over reinforced concrete walls, in well-drained soils, where landscaping keeps water away from the base of the building, in basement mechanical areas, with no interior finishes. And there may be few complaints. This does not mean that troweled-on mastic is a reliable waterproofing system. Don't try using it in wet soils where there are interior finishes! Before you select a material, you have to know that its properties make it suitable for the intended use.

8) **The Vapor Barrier is Critical to Preventing Water Damage**: The Canadian government has funded much outstanding research on building performance, and demonstrated the need for effective air and vapor barriers. In Canadian climates the air is very dry, and people tend to run humidifiers during the winter. Subzero climate plus interior humidification is a potent combination that requires careful attention to vapor control.

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The problem is that vapor dynamics depend entirely on climate conditions and occupant habits. A little further south the situation is not so clear. For example, exhaustive studies of the Sterling Library at Yale University, conducted when the University decided to humidify the library stacks to 50% RH all year long, showed that no vapor barrier at all was advisable for the massive masonry exterior walls, because of seasonal reversals in the vapor drive. (The windows were another story; all the original windows were replaced with new windows that have high condensation resistance.) In the Deep South the situation reverses itself, and interior vapor barriers plus interior air conditioning are positively harmful. They support the growth of mildew and all sorts of harmful "critters".

As a practical matter, in mid-Atlantic and even most New England locations, interior condensation causes few problems. Water leakage from rain and melting snow ought to be a far greater concern than water condensation originating with the interior, except for humidified environments such as greenhouses or enclosed swimming pools. Enclosed swimming pools have unique problems, exacerbated by the use of chlorine in the water, and require strict precautions not needed in other types of construction.

9) **Ratings Are a Measure of Product Performance**: When a manufactured product comes with a rating system, it's tempting to believe that the right thing to do is to rely on the manufacturer's instructions to choose the appropriate level of protection for your application.

For example, the window industry has a rating system that classifies windows by their ability to pass structural, air infiltration, and water resistance tests when they are new. If you follow window industry selection criteria, for a given height and wind exposure, you will choose a certain grade of window such as an HC-40, which corresponds, to a "Heavy Commercial Type, 40 psf Structural Performance. This window, in new condition in the factory, should be able to pass a water penetration resistance test at 10% of the structural pressure, or 4 psf. So far so good. The problem is, that when real, aged windows actually leak in real installations, they inevitably leak at zero psf. In our experience, the main cause of the problem never turns out to be that the wrong grade of window was specified. It's because water drips onto the window heads from the spandrels above the windows, or water leaks under the sill of the windows and collects on the floor slab, or the material used for the thermal breaks has shrunk and created a gap, or the window perimeter sealant has no surface to adhere to. And the rating system conveniently sidesteps the issue that almost no aluminum windows are made with sloped horizontal surfaces that drain the exterior. Even the most expensive aluminum windows today have sealant-filled corners held together with screws, which will eventually need rehabilitation as the sealants deteriorate.

Of course it's important to understand and use appropriate product selection criteria. But industry criteria are industry-specific. The window industry does not go out of its way to tell architects that flashings are needed to keep water from dripping onto the head of the window below. It is not their business to teach architects how to do their job. Nor is it their business to call attention to any overall decline in industry standards. They are just trying to make their current products easier to understand and use.

10) **A Product's Name Tells You Something about Its Properties:** The construction industry, like many other industries, is heavily influenced by advertising and name brands. A good name creates a sense of assurance and familiarity. A name like "Housewrap" creates the impression that houses ought to be wrapped in something. A term like 'waterstop" creates the impression that it stops water. Or the term "water repellent coating" may convey the idea that applying a coating can stop water entry.

The problem is that products with vivid or appealing names get chosen for the wrong reason. Would you use "masonry sand" if you were making mortar for masonry? Sand that has been engineered for use in mortar is known as ASTM-C144 sand. In our experience, sand that is marketed as "masonry sand" often does not meet the appropriate standard.

A little-known laminated product with the less catchy name "Sisalkraft" performs very well as an underlayment for wood siding, but the U. S. market is dominated by "Housewrap", whose properties make it a better air barrier than water barrier.

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An aggressively promoted "green" roof system that accommodates insulation and soil on the surface, is simply a cold-applied asphaltic membrane marketed as a "green" roof. The asphaltic membrane is not the most durable choice of roofing membranes; heat-welded reinforced PVC will be many times more durable.

The moral of the story is to choose materials based on their properties, not on the way they are marketed.

Questions, comments, or suggestions? Email the authors at mab@leavittassoc.com or visit our web site at www.leavittassoc.com

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