The Heartbreak of Building Psoriasis

Restorative engineers are giving local buildings much needed makeovers


Courtesy San Jacinto Museum

BY RIVES TAYLOR

HOUSTONIANS have become accustomed to seeing their architectural monuments shrouded in scaffolding, especially following a tropical pounding. But heavy weather isn't always the culprit. Our façades are starting to exhibit cladding malfunctions common to the early-20th-century skyscrapers of New York and Chicago. While our large buildings use newer materials such as stainless steel to fasten their curtain walls to buildings' structural frames, the method of hanging the face of a building—a mechanical gravity fastening system—has remained essentially unchanged for a century. And therein lies the problem.

Cladding failures have occurred at Jones Hall and the Lyric Centre office tower downtown, the Medical School Building at the University of Texas Health Science Center at Houston, and at the San Jacinto Monument. Each was clad in limestone, travertine, or Texas sandstone, just like the older buildings of the University of Houston and the newer buildings of Rice University. Forensic and restorative engineering firms are now in Houston working to learn from our recent incidents. One of these firms—Wiss, Janney, Elstner Associates, Inc. (WJE)—is experienced in diagnosing exterior wall failures and repairing the problematic designs, having participated in a massive cladding cleanup in Chicago in the 1990s.

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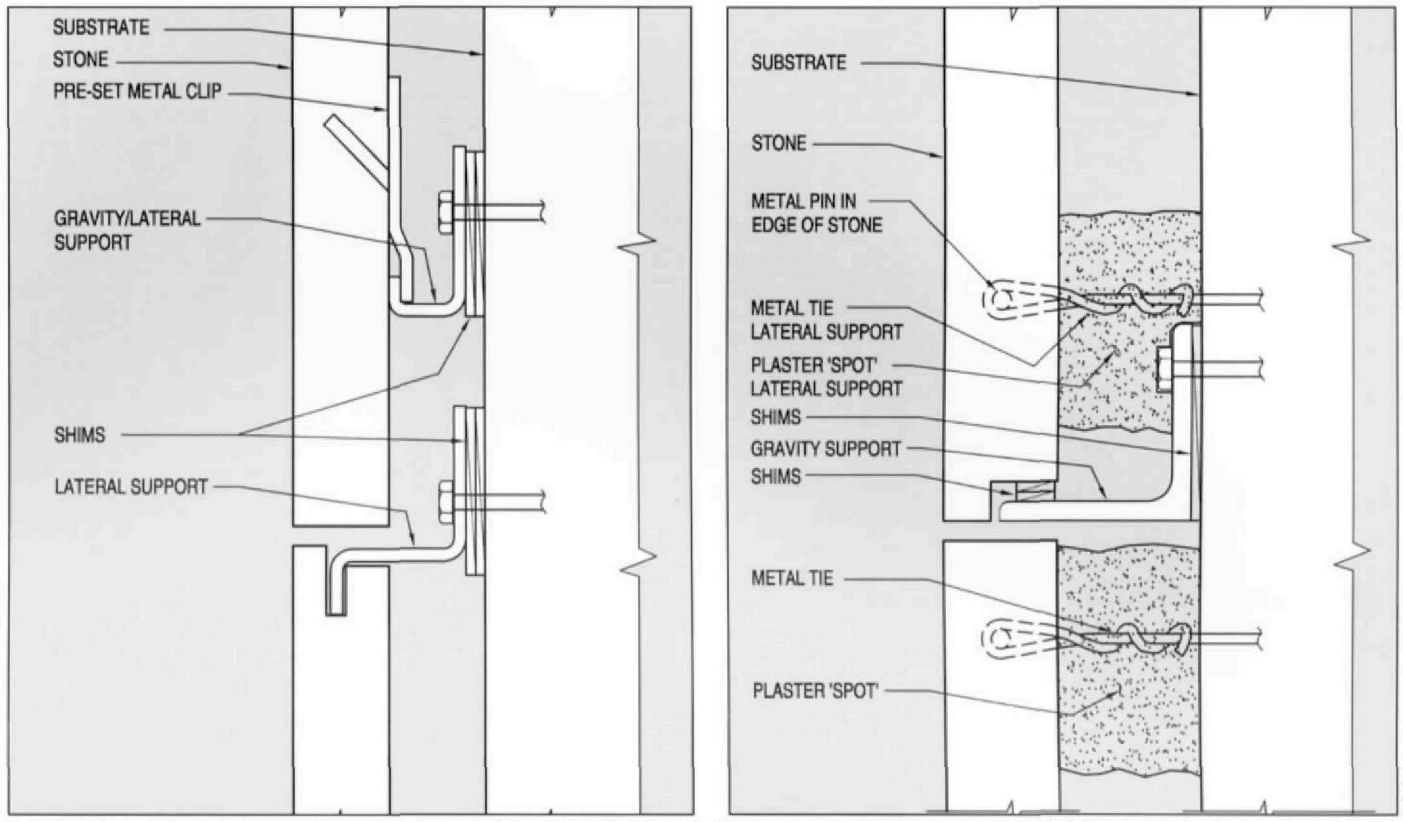
Skyscrapers that were erected at the turn of the last century were clad in small bricklike pieces of porous stone or terra cotta. Corrosive rain and air, together with the freeze-thaw action of the northern-city climates, caused the stone to crack. Moisture seeped in and attacked the often-untreated iron hangers that held the small stones.

The architectural pioneers of the Chicago School moved away from the use of small stones and toward the elemental curtain wall—preassembled large panels of thin stone, terra-cotta, or metal and glass. Often the panels' size had as much to do with architectural detailing—as in the ornate terra-cotta of Louis Sullivan—as it did with the availability of technology to lift and affix the panels. (Later, the Empire State Building reverted to the use of smaller brick units resting on steel sills, in part because of the availability of masons in the New York area, and in part to avoid lifting heavy panels over crowded New York streets.) In addition to architectural aesthetics, the march of progress pushed for larger panels, too. Post-World War II industrial culture encouraged large factory-built panels over individual masonry piecework.

The panels were designed to be fairly light and easy to fasten to the quickly erected steel skeleton of the new high-rise. Hooks bolted to the building superstructure were aligned with metal stays integrally cast into the man-made stone or concrete panels. The skeleton was utilized both to hold individual panels' weight and to resist the buffeting lateral loads of wind caught by the panels. Redundancy of connection between building and panels helped to contain the shifting and multidirectional loads and avoid disastrous shearing of those metal linkages. In turn, the panels could move somewhat independently on the pin connections to expand and contract with surface temperature variations, protecting the steel skeleton behind from temperature swings and damaging moisture.

But the technologies that proved indispensable to curtain wall success were the external metal flashing and interpanel seals. High-rise curtain wall engineers foresaw that water running down both faces of the panels would cause deterioration of both the panel material and those metal hooks. Seals produced the needed waterproof envelope. Tar eventually gave way to rubber and silicone, but all



Cladding attachment systems (above); opposite page: A hole at the top of the world: Pieces of cladding fell from the face of the San Jacinto Monument in 1992. The monument has since been fully restored.

sealants required regular inspection and maintenance, as weathering led to their inevitable failure. Rarely were skyscraper owners prepared for the challenge and cost of this maintenance.

While builders of skyscrapers embraced sleeker and more homogenous curtain walls framed by aluminum or stainless-steel mullions, the battle to keep the destructive corrosion brought about by moisture within the wall continued. Designers looked to advanced glass-to-window-frame gasketing and water-shedding mechanical fastenings. New materials and state-of-the-art approaches were tried and then discarded as less than optimal—after dozens of façades were hung and left to survive on their own. The 2001 restoration of the Lever House in New York City uncovered not only the failure of the sun-baked rubber gaskets but also corrosion due to moisture within the otherwise sealed wall.

The postwar era saw the reintroduction of increasingly lighter stone or concrete panels with ever-thinner layers of masonry on aluminum backing. This thinness imparted a more solid appearance to the curtain wall, as can be seen right here at home: For all its massive masonry appearance, Jones Hall is a steel building covered in large thin travertine stone panels supported by concrete masonry unit walls, concrete columns, or steel frames.

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Those earlier façade failures in northern cities, similar to what was discovered at the San Jacinto Monument prior to its restoration in the late 1990s, were due to the degradation of the metal ties and anchors that held terra-cotta to terra-cotta or stone to stone. When steel suffers repeated exposure to acid rain, it faces two possible ends: simple corrosion or outright rust. Over the longer term, weakening of connections also came about through unforeseen galvanic action. (The nature of electrolytic interactions between ferrous metals, or between metal and stone or concrete, is often discovered only years after the original erection. For example, a number of precast concrete panels hung on local structures made use of an add-mix of sodium chloride to achieve a faster cure time. When exposed to moisture, this salt in the concrete can corrode embedded ferrous steel.)

Thin travertine cladding poses a different challenge. "What we have seen on several local projects," says Mark Hopmann, P.E., branch manager of the local WJE office, "is how problematic travertine is as a thin cladding material, particularly on buildings with historically low maintenance." Hopmann notes that travertine's problems stem from its veining and porousness, which make it a weaker stone facing than most. In fact, WJE does not recommend the use of travertine as exterior cladding. But when travertine is used, proper support connections and material thickness are imperative. WJE also advocates that the surface be smoothed and sealed ("parged") with a special mortar mix that not only helps repel water but also keeps the panels cleaner by allowing them to shed water more quickly. Of course, this treatment costs more initially but can add years to the material's life and good looks. However, a parged surface still requires regular maintenance to be effective in the long term.

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Hanging panels on the structural skeleton has proved to be an effective and first-cost sensible approach; however, the vagaries of the construction process, long-term wear and tear, and substandard maintenance are not accounted for in design. In design, panels are often encumbered by attachments such as soffits or ledges that introduce still more metal connectors. These also can corrode, and act as metal wedges in the stone panels, ultimately forcing away ("spawling") pieces of the stone.

Finally, the failure of the chemical seal around the ever-shifting panels can lead to water infiltration into the curtain wall cavity, especially on increasingly maintenance-challenged public buildings. Power-washing, often mistakenly used to keep a building clean and "maintained," can blow apart what is left of the aging sealants as well as open further cracks in the outer stone face. Repeated high-pressure water treatments, with or without chemical solvents, have been found to degrade even the metal finish protecting the host panel. The high-pressure attack on the stone or metal panel thus operates on both faces.

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Hopmann reports that his company has been asked by the cities of Chicago and Milwaukee to assist in creating ordinances for both new and restorative design processes that address cladding failure. These ordinances, as well as those of other cities that enforce tough standards of façade performance (such as New York, Boston, Detroit, Columbus, St. Louis, and Pittsburgh) are posted on the Web site faceordinance.com. U.S. materials testing agencies also will be addressing façade issues, possibly requiring that all fastener material be made of more expensive but durable stainless steel, a nonferrous (and therefore nonreactive) material.

Another available approach to curtain wall durability is the weather screen. This system recognizes that the outer skin can do little but shade the inner building from the weathering impacts of our climate—especially the sun's ultraviolet rays, which ultimately damage all materials. Since the cladding in this instance is a simple shade, a breathing sunscreen, no interpanel sealing is required; the more important and delicate insulation against water and vapor is located within a second, protected skin. While the outer panels can manifest the aesthetic of any number of materials, the inner skin is as functional and sealed as possible. The light outer panels, hung on stainless-steel or aluminum assemblies, can expand and contract on the same fastener mechanisms as on earlier skyscrapers, but with substantially less worry about weight or the durability of interpanel seals.

Cladding decay (and the professional focus it brings) has been the engine of great technological innovation, in both new construction and repairs. However, the financial squeeze on the owners of older, cladding-challenged buildings does not bode well for use of this new knowledge. If owners skimp on retrofitted mechanical connections or on maintenance, we will only face another round of buildings with skin problems in the future. And as every actor, model, or television anchor knows, if you don't take care of your skin, your career could soon be over. ■