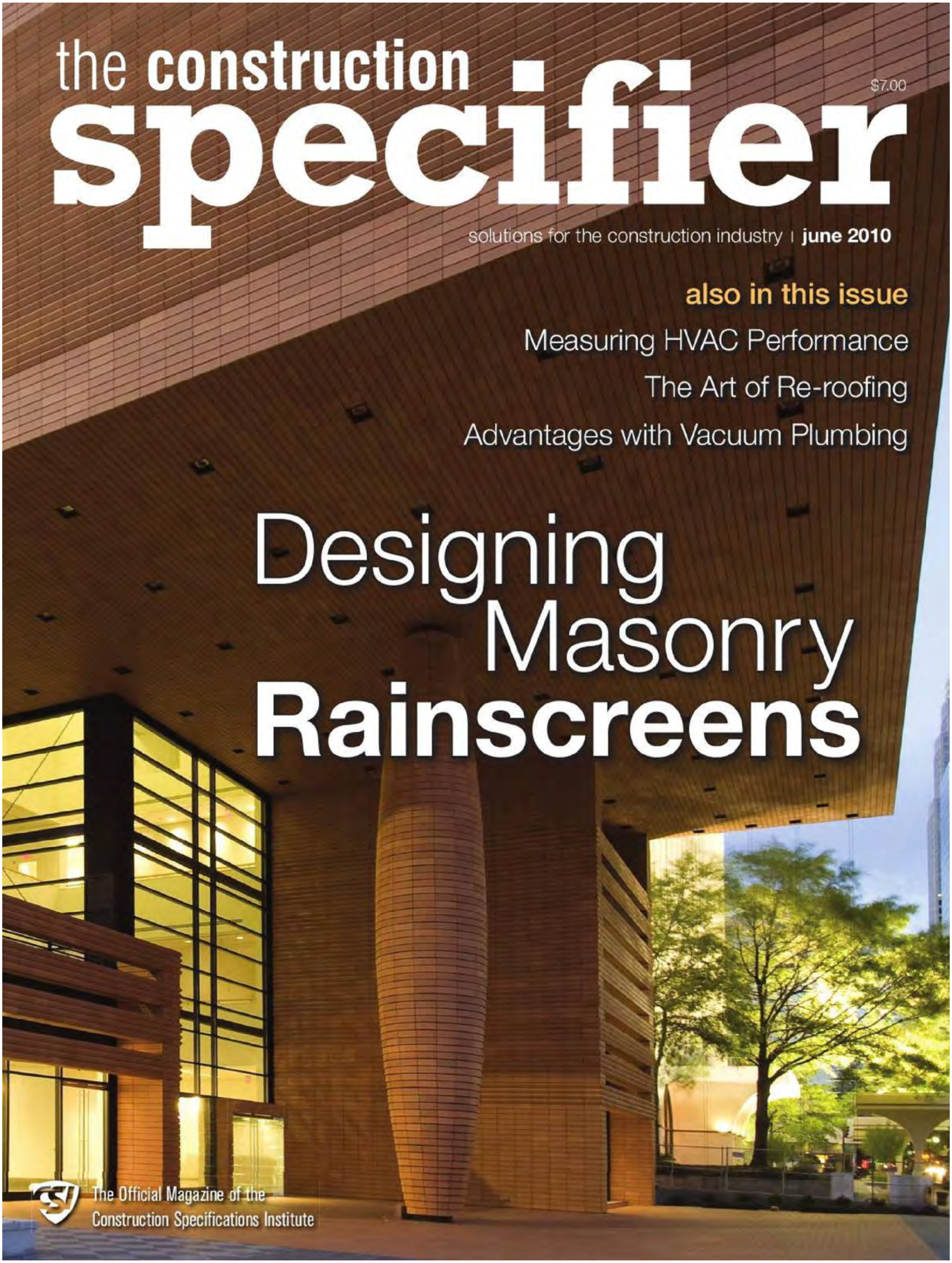

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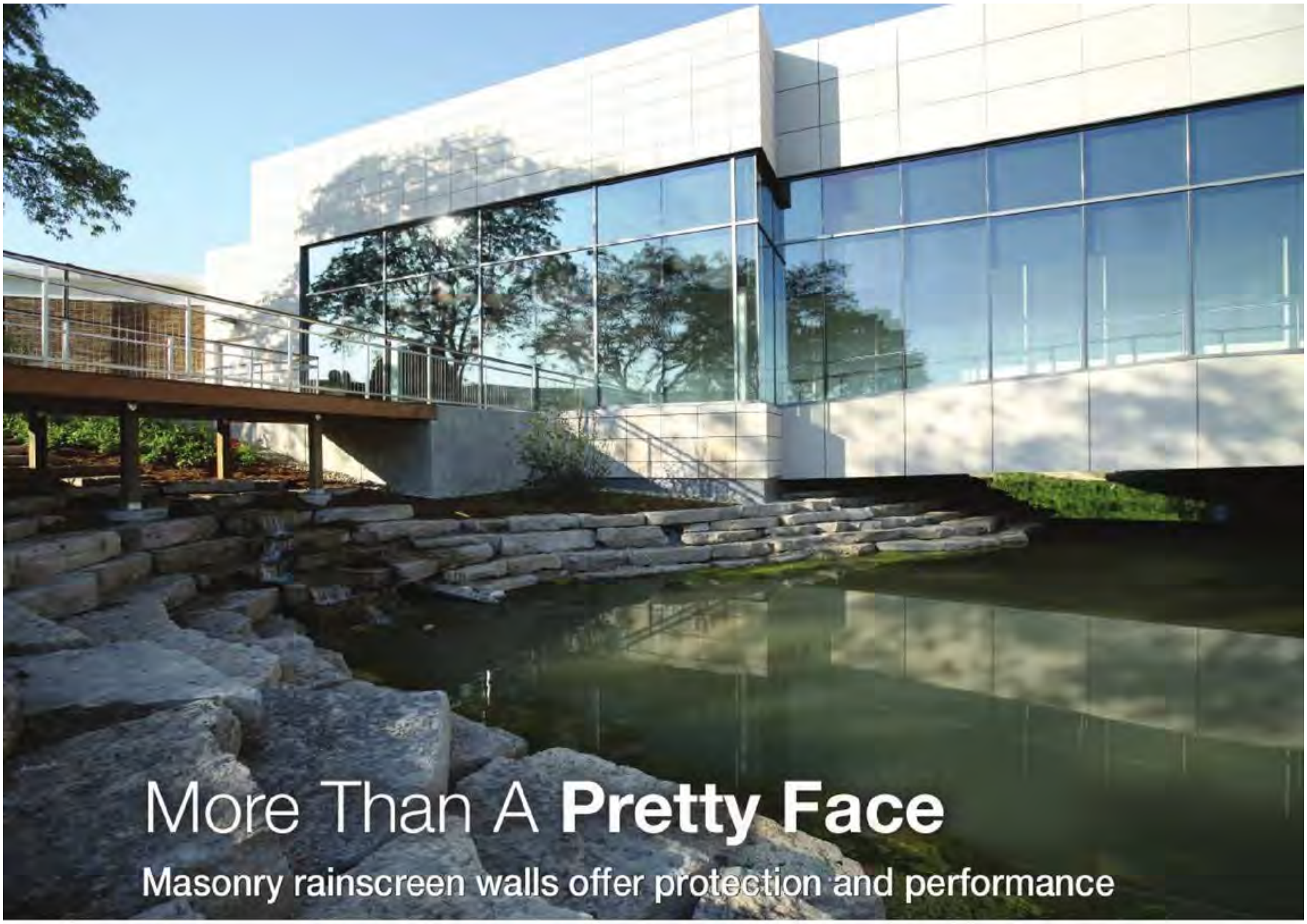

More Than A **Pretty Face**

Masonry rainscreen walls offer protection and performance

by David Sovinski and Pat Conway, AIA, CSI

Photos courtesy IMI

AT THE HEART OF BUILDING PERFORMANCE, A BUILDING ENVELOPE HAS SEVERAL CRITICAL JOBS TO PERFORM, INCLUDING KEEPING THE RAIN OUT WHILE CONTROLLING AIR LEAKAGE, VAPOR DIFFUSION, AND HEAT TRANSFER. IT SHOULD ALSO LOOK GOOD WHILE DOING IT.

Historically, one of the reasons masonry walls were designed as mass barriers for structural reasons was to keep water out of the building. Due to their sheer mass, this concept worked well to control moisture, but traditional masonry walls could still be damp and cold. These barrier systems also take up valuable space in the exterior wall that could be used for occupancy.

As building envelope science evolved, it brought the realization capillary action could be stopped within reservoir material assemblies (*e.g.* masonry and concrete) and further inspired the search for improving the envelope.

To break the moisture transfer due to capillary action within masonry barrier walls, the cladding was separated from the backup wall by an air space, and the concept of a simple rainscreen wall evolved. In this unventilated cavity wall approach, the outer masonry wythe served as a 'screen' to deflect rain, while the air space provided a drainage plane to prevent water from penetrating the backup wall. Later, accessories—such as weeps and vents—were added within the wall (properly located on the building structure's exterior side), allowing it to drain while controlling air leakage, vapor diffusion, and heat transfer.

Rainscreen technology helped create a drier and warmer interior building environment, yet rain could still penetrate the outer masonry wythe and collect within the wall, potentially working its way into the building. According to the Masonry Standards Joint Committee's (MSJC's) *Building Code Requirements and Specification for Masonry Structures*, Section 6.6.1.6, "water penetration through the exterior veneer is expected."[1]

This article explores rainscreens, drawing on case study examples from across the United States.

Ventilated rainscreen walls

The next evolutionary step was to introduce opportunities for water to drain out of the wall with a system of flashing and weeps; sometimes dampproofing material was applied to the backup wall's cavity side. Afterward, it was realized exterior building envelopes in most U.S. climates should be designed with the ability to both drain and dry with weep vents located low and high in the cladding—this led to the ventilated rainscreen wall. These walls expel the inevitable vapor drive out the reservoir cladding's backside, allowing walls to dry more quickly and eliminate long-term saturation that can cause staining, spalling, and other moisture-related issues in wall assemblies.

The Kerry America corporate headquarters in Beloit, Wisconsin, won the International Union of Bricklayers and Allied Craftworkers (BAC) Craft Award for best terra cotta rainscreen wall.

Pressure-equalized rainscreen walls

While these walls had the ability to drain and dry, the search continued to find ways to keep bulk exterior moisture out of the wall cavity. This brought the realization that keeping water out meant either the water had to stay off the wall, the openings within the cladding needed to be eliminated, or the force to push/pull water through the cladding had to be neutralized.

The most practical of these three options is neutralizing the water's driving force by introducing adequate air behind the cladding to eliminate pressure differentials across it. If done correctly—with a proper air barrier system on the backup wall, air space compartmentalization, and adequate weep vents both high and low—the result is called a 'pressure-equalized' rainscreen wall.

Some manufacturers claiming to offer pressure-equalized assemblies are actually just providing well-ventilated ones. To achieve adequate net intentional openings in the cladding as a ratio of the contained air volume behind, there needs to be an abundance of weep vents. This ratio is debatable based on proposed theoretical formulas, but can be verified with experienced field measurements.

The calcium silicate masonry units chosen for Rutgers' Livingston Student Center worked well for the project's tight budget and schedule, while fulfilling their wish list for aesthetics, color, environmental sustainability, durability, moisture management, and future extendibility.
Photo courtesy Arriscraft International

Chicago's Cook County Domestic Violence Courthouse was an early appearance for rainscreen walls. The terra cotta system started with a structural block wall, then a waterproof membrane and rigid insulation.
Photo courtesy IMI

Simple rainscreen walls make attractive and durable choices for hardworking buildings, like Grand Rapids' Gerald R. Ford Airport garage.
Photo © Brett Drury. Photo courtesy Boston Valley Terra Cotta.

Open-jointed rainscreen walls

One popular building envelope solution that allows a large quantity of air behind the cladding is the open-jointed masonry rainscreen wall. These excel at the basic principles of keeping water out of the building while also controlling airflow, vapor diffusion, and heat transfer. Many open-jointed systems actually have baffles or shiplapped joints to minimize water penetration through the exterior cladding while promoting generous airflow behind it.

Open-jointed systems eliminate the driving force of a pressure differential across the cladding. The cladding's primary function is to deflect rain while protecting the moisture/air/vapor control layers inside the wall from ultraviolet (UV) light degradation.

Embraced for years in Europe and Canada, these contemporary rainscreen walls are now attracting a lot more attention in the United States due to the push for energy efficiency and sustainability, in addition to what they offer in terms of performance and aesthetic appeal.

Performance

The walls' natural ventilation reduces the risk of mold, mildew, and corrosion within the cavity, and offers the prospect of long-lasting buildings, resistant to harsh weather challenges and fading. The absence of sealant or mortar in open-jointed systems further reduces the need for sealant replacement or repointing. Having continuous insulation outside the air/vapor barrier allows continual evaporation, which significantly boosts the insulation value by minimizing thermal bridging and reducing energy demands.

Many channel-anchored open-jointed systems decrease the thermal bridging at connections with thermal breaks provided by minimal contact to the backup wall or the combination of air barrier material and exterior sheathing.

With both structural and non-structural masonry backup walls, the building envelope can take advantage of the R-value of continuous insulation on the wall's exterior side, along with the thermal mass multiplier found in American Society of Heating, Refrigerating, and Air-conditioning (ASHRAE) 90.1, *Energy Standard for Buildings Except Low-rise Residential Buildings*. Cladding connections to the building are often plugged with self-healing material to help control airflow and stop moisture migration.

For channel-anchored masonry rainscreens, it is important to specify a system that allows water to drain down the masonry cladding's backside and eventually out of the wall. Depending on the manufacturer, some systems have gaps between the channels and the cladding and/or wall insulation. At least one manufacturer has a network of holes pre-drilled into the channels to aid the downward flow of moisture and the upward flow of air. There is no need to compartmentalize the air space behind open-jointed cladding systems since horizontal airflow within the wall cavity is not a concern.

The rainscreen wall's flexibility helped designers at HGA Architects realize their vision of having the stone 'float' over the windows, while the contractor understood how the mortar-less joints made winter construction easier and faster.

Photos courtesy Arriscraft International

Virtua's Health and Wellness Center in New Jersey is one of four new buildings on three campuses using pressure-equalized open rainscreen systems.

Sustainability

Durability and energy conservation are two of the most important attributes of sustainable design. All three types of modern masonry rainscreen walls are superior performers in these categories.

With their ability to drain and dry, rainscreen walls out-perform other non-draining barrier or skin wall concepts. Land-filling buildings or recycling building components after a short (*e.g.* 50-year) lifecycle is not sustainable. Modern masonry is lighter, impact-, vandal-, and fire-resistant, colorfast, and requires less maintenance than ever. If a panel within a channel-anchored open-jointed masonry cladding is damaged, it can easily be replaced by shifting adjacent panels.

Another sustainable point of masonry screen walls is the choice of natural and local materials, which can help meet Leadership in Energy and Environmental Design (LEED) requirements and complement existing buildings and neighborhoods.

Todd Schliemann, an architect with Polshek Partnership Architects (New York), said his company has long embraced rainscreen principles, as have their institutional clients in particular.

"By using drained and ventilated panels and by placing the moisture, air, vapor, and insulating control layers behind the cladding, but outboard of the building structure, it achieves significant advantages," he said.

Aesthetics

When it comes down to the final design decision, it is often about looks. Many designers are embracing rainscreen walls because of the crisp, clean, contemporary appearance they can offer. They also like the idea of using traditional masonry materials in modern systems and for fitting new structures into the context of existing building stock. The cladding—and re-cladding—options for masonry rainscreen walls include:

- ceramic tile (in various colors and textures);
- terra cotta;
- brick;
- calcium silicate; and
- stone.

Peter Biber, from The Biber Partnership (Summit, New Jersey), said image and color were everything for the Livingston Student Center project at Rutgers—the State University of New Jersey.

"We wanted to achieve a homogeneous feeling and we were concerned about the range we would get in limestone," he said. "This material gave us the quality of mass combined with color that we were looking for. We wanted a monolithic feeling in the building."

Consistency was especially important as his firm is currently working on a sister building, the Livingston Dining Commons, and is concerned about future extendibility.

As Biber was facing a tight schedule and budget, he chose a 0.3 x 0.6-m (1 x 2-ft) panel that allowed for quick and easy construction, including through winter.

"The image quality had to be extendible," he explained. "The panels became much more economical to install while giving us exactly the image we wanted."

At the National Collegiate Athletic Association (NCAA) headquarters in Indianapolis, Indiana, Ratio Architects chose terra cotta for an expansion project. The reasoning was because of the material's warm appearance, according to the firm's Jeff Milliken, LEED AP.

"We were adding to a brick building, so the desire was to keep the warmth," he said. "It's a modern system, but it allows for an integrated look, and feels like a single system."

IMI helps familiarize designers and contractors with new products like rainscreen wall systems, and trains International Union of Bricklayers and Allied Craftworkers (BAC) members.
Photo courtesy IMI

The masonry contractor became an exterior wall specialist for the Bryant University Interfaith Center in Rhode Island, which featured a rainscreen wall system along with reinforced lightweight limestone panels.
Photo courtesy Bryant University

A bonus was the manufacturer also offered terra cotta sun-shade louvers. Extra energy efficiency came from 51 mm (2 in.) of rigid insulation and 38 mm (1.5 in.) of sprayed polyurethane foam (SPF) insulation that expanded to fill seams, plus a fluid-applied air barrier.

In Chicago, one of the earliest rainscreen walls showed up on the Cook County Domestic Violence Courthouse using a terra cotta system. It started with a structural block wall, on which a waterproof membrane was applied and topped with 51 mm of rigid insulation.

Masonry rainscreen walls are often turning up on parking garages, like Grand Rapids, Michigan's Gerald R. Ford International Airport, which used terra cotta, and Purdue University (West Lafayette, Indiana) with ceramic tile for aesthetics, durability, and low maintenance.

One building sector leading the rainscreen charge is healthcare, with many hospitals and laboratories welcoming solutions for meeting higher performance standards, and in turn, improving patient outcomes by eliminating places where moisture and organisms thrive. It is vital to have a high level of performing air barriers properly located on the warm side of the primary wall insulation layer to separate the pressurized high-humidified interior building spaces common to healthcare facilities from the exterior environment—especially in cold-weather climates.

More airflow also means less air conditioning and, in turn, less carbon dioxide (CO_2) emissions—plus energy savings and long-lasting buildings. The installation of air barrier systems can pay for itself in less than six years, or aid project cash flow by subsidizing value at a low cost.

Rainscreen tips

Specifying any exterior façade system demands close attention, and that is especially true with rainscreen walls.

According to Davenport Masonry (Michigan) president Ed Davenport, the problem is in the details, especially when it comes to the air barrier. The key consideration is detailing the air barrier and its terminations properly to ensure a continuous and durable wall that correctly vents and drains. Davenport urges specifiers to communicate clearly with construction managers, and Ratio's Milliken agrees.

"All these pieces and parts are very integrated, which we like, but it is important to have somebody who has responsibility for the construction side," he said.

This is where a good masonry contractor comes in. The best way to ensure proper performance—and avoid problems—is to have a single source of responsibility for the exterior building envelope. Bringing the masonry contractor to the table from the very beginning proved particularly beneficial

With a large project and new, open-jointed rainscreen wall technology, the team used an oversized mockup for the Johnson Controls building (also pictured on page 24).
Photo courtesy IMI

for the 11,557-m² (124,400-sf) Johnson Controls' Global Headquarters Expansion project in Glendale, Wisconsin. Designers expressed their intent, but refrained from dictating the specific solution, preferring instead to let it evolve with the construction team's input.

Along with the thick-stone open-jointed rainscreen wall, other innovations for the building envelope included custom anchoring, a unique insulation system, and a durable water/air/vapor barrier.

Looking at the original design with all open joints, a flexible and durable channel-anchored system was proposed by Kinateder Masonry. Each dramatically sized 406 x 762 x 76-mm (16 x 30 x 3-in.) thick panel was independently supported, and various innovative veneer anchorage options were also suggested. In the field, masons worked from both the designer's and limestone supplier's plans to line up the joints.

When sealant is specified between masonry units, it is recommended to match it to the cladding color, and have the same group of caulkers throughout the process. For most climates, when the joints are filled with either mortar or sealant, weep vents should be installed so the wall can drain and dry.

Another handy tool used by the project team was an oversized mockup that helped pave the unfamiliar terrain of open-jointed rainscreen wall technology. For New York City's Second Avenue subway project—which has a combination of exterior and interior screen walls of porcelain tile, terra cotta, and granite—manufacturers are working directly with the International Masonry Institute (IMI) on customized training programs and mockups that will let the contractors begin right away. **CS**

Notes

[1] The MSJC code is known as The Masonry Society (TMS) 402/American Concrete Institute (ACI) 530/American Society of Civil Engineers (ASCE) 5, *Building Code Requirements and Specification for Masonry Structures.*

ADDITIONAL **INFORMATION**

Authors

David Sovinski is the International Masonry Institute's (IMI's) national director of industry development. IMI represents an alliance between the International Union of Bricklayers and Allied Craftworkers (BAC) and union masonry contractors. His experience includes masonry project manager, estimator, and architecture and technology teacher at Indiana University Purdue University Indianapolis (IUPUI). Sovinski has a degree in construction management from Purdue University. He can be contacted via e-mail at dsovinski@imiweb.org.

Pat Conway, AIA, CSI, is IMI's area director of market development and technical services in Wisconsin. He is a registered architect, with expertise in masonry rainscreen walls, air barriers, movement joints, flashing, jobsite troubleshooting, and contemporary masonry wall detailing. Conway has a degree in architecture from the University of Minnesota, and is an active member of both the American Institute of Architects (AIA) and the Construction Specifications Institute (CSI). He can be reached at pconway@imiweb.org.

Abstract

At the heart of building performance, a building envelope has several critical jobs to perform, including keeping rain out while controlling air leakage, vapor diffusion, and heat transfer. Historically, masonry walls were designed as mass barriers for structural reasons and to keep water out of the building. Due to their shear mass, this concept worked well to control moisture, but traditional masonry walls could still be damp and cold. However, as building envelope science evolved, it brought the realization that capillary action could be stopped within reservoir material assemblies.

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