

building the cladding palette: PANELS, RAINSCREENS, AND VENEERS

THIEMO EBBERT/ COURTESY SOLARLUX



Above: To naturally heat the perimeter at Solarlux's new administration building in the Netherlands, a sophisticated operable double façade system opens up some of the doors in the inner façade to bring in warm air heated in interstitial space through solar gain, and provide natural ventilation. Meanwhile, the outer skin remains closed so that it can optimally function as a solar air collector. Above right: During the summertime, the outer glass is fully opened and the inner façade is completely closed to optimally extract heat build up while protecting the inside from solar heat gain.

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CONTRIBUTING EDITORS

When it comes to cost, performance, and aesthetics—not to mention maintenance and long-term resilience—the evaluation of cladding materials and façade systems is more complex than ever. As with any critical system or product, Building Teams must weigh pros and cons to arrive at the ideal wall assembly for any project. Expanded offerings in cladding panels, veneer products, and rainscreen systems make it easier to accommodate varied uses but also entail limitations.

Building Teams are exploiting the qualities of these new systems, with projects such as a “billowing concrete” façade of fiber-cement casts designed by EM2N for a new railway service facility in Zurich, Switzerland (<http://bit.ly/1pX49QH>). Or the 352 ribbons of steel mesh—meant to reduce solar gain—added to a \$25.5 million retrofit of the Dallas Cotton Bowl Stadium by architect Jamie Carpenter (<http://bit.ly/1qmakQd>). Then there's the stunning competition entry for a Dutch water utility building by Delft-based design studio DP6, with a skin of clear foil resembling bubbles or water droplets (<http://bit.ly/1pX3EGf>).

To help Building Teams sort through their options, veteran enclosure specialists—and some savvy owners and construction

LEARNING OBJECTIVES

After reading this article, you should be able to:

- + LIST seven major types of façade materials and their primary effects on building construction and operating costs, sustainability, and occupant well-being.
- + DISCUSS problems of thermal bridging and techniques for ensuring walls have the desired R-value for optimal energy efficiency.
- + UNDERSTAND the components and thermal characteristics of a double-walled façade.
- + DEFINE the features of a rainscreen, including drainage characteristics.

experts—offer insights based on experience and best practices. Among the most important take-aways? For every benefit in initial cost, scheduling, and ease of installation, weigh potential drawbacks in long-term performance and maintenance.

UNDERSTANDING FAÇADE MATERIALS

Specific characteristics should leap to mind for standard choices in façade materials—even if they are used in decidedly nonstandard ways. Here’s a summary of the most typical choices.

Metal cladding. Insulated metal panels (IMPs) and metal skin cladding, along with composite metal panels, are considered a cost-effective way to clad exterior walls, with a variety of colors, textures, and styles available. For example, corrugated metal panels are a common choice for Building Teams seeking a high-tech look—a sharp departure from their former agricultural and industrial connotations.

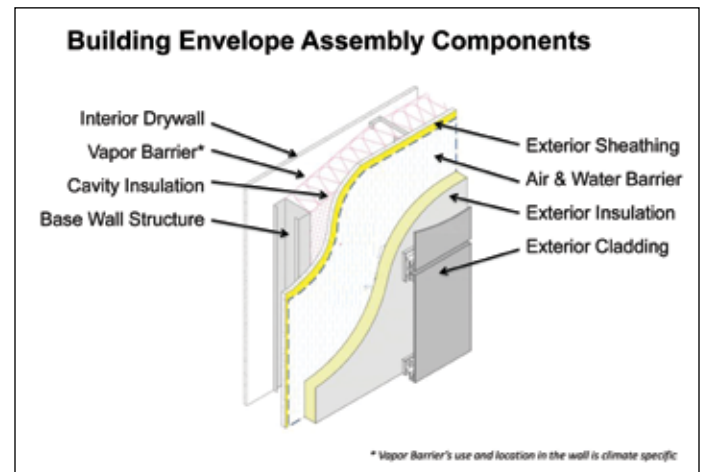
Thomas Chinnock, AIA, an Architect in the Phoenix office of Shepley Bulfinch (www.shepleybulfinch.com), agrees that metal cladding panel aesthetics are usually appealing. This is particularly true in situations where the manufacturer shapes the panels to request, and the specifiers can choose their own joinings and trim. “However, when a pre-established system is used, we are subject to manufacturers’ standard trim and joints, which tend to be larger than necessary because of their self-assigned tolerances,” says Chinnock.

IMPs and other metal façade assemblies are also known for their relatively light weight, which makes them cheaper to transport and easier to erect. It’s fairly simple to support metal panels off a substructure and barrier wall to allow for an ample cavity with plenty of continuous insulation, says David Altenhofen, AIA, a Building Enclosure Consultant and Manager with The Façade Group (<http://facadegroup.com>). Another benefit is longevity, adds George M. Blackburn III, AIA, NCARB, General Manager of Construction Consulting International (www.sunited.com). He cites the stainless steel panels atop of New York City’s Chrysler Building as proof of the long-term stability and successful application of metal cladding.

Blackburn warns that material selection is critical. “I have seen corrosion of some steel alloys, where the panels have completely rusted through in a relatively short time,” he says, mentioning “weathered steel” products meant to form a rustlike finish that eliminates the need for coatings or finishes.

Generally speaking, however, metal is quite durable, though performance depends on proper detailing. For example, Chinnock says Building Teams should not rely on joint sealants for long-term weather resistance.

“Any system with sealant joints adds the risk of the sealant attracting atmospheric dirt and then staining the panels during a rain,” agrees Altenhofen, who helped found the AIA Philadelphia’s chapter of the Building Enclosure Council and is co-chair of the BEC’s National Research Committee, as well as sitting on the National Institute of Building Science’s Building Energy and Thermal Envelope Council (BETEC). Blackburn—a member of the BEC-Dallas Chapter as well as BEC’s National Research Committee and the BETEC Board of Directors—advises specifiers not to use metal panels in



COURTESY DUPONT BUILDING INNOVATIONS

Depicted above are the components of a typical building enclosure assembly, including insulation and barriers. The correct use and location of the vapor barrier within the wall is climate-specific.

face-sealed wall designs in which all joints require sealant to prevent water penetration.

While the metal panels themselves are frequently airtight and watertight, their joints are not, and so the cladding systems require proper air barriers, says Richard Keleher, AIA, CSI, LEED AP, a Senior Architect with Thompson & Lichtner (<http://thompsonlichtner.com>). He advises Building Teams to carefully review claims made by panel producers about the air and water tightness of a complete system, since air barriers may not be a part of a given manufacturer’s product. A related issue has been the prevalence of poorly installed air barriers for metal cladding systems; in fact, several major suppliers of metal composite panels recently teamed up with the American Architectural Manufacturers Association and Architectural Testing to develop two tests to properly evaluate open-jointed systems. The resulting standards are AAMA 508 for pressure-equalized rainscreen systems and AAMA 509 for back-ventilated and drained rainscreens.

“The objective is to have the least water penetration and the most ventilation,” explains Keleher, who also sits on BETEC’s Board of Directors and co-chairs AIA Boston’s BEC Chapter, which he helped found. “AAMA 509 provides performance on two scales—water penetration and ventilation—with a numerical range in each category from one to 11.”

Exterior insulation and finish systems. Transcending first-generation products from the late 1960s, today’s exterior insulation and finish system assemblies can provide a cost-effective, high-performance solution, according to William R. Brody, VP with the construction management firm B.R. Fries & Associates (www.brffries.com). “When detailed properly, EIFS offer a plethora of advantages,” says Brody. “The thermal value is very good, and the entire system is usually outboard of the structure, providing continuous insulation that reduces energy losses caused by thermal bridging.”

In addition, says Shepley Bulfinch’s Chinnock, a continuous building wrap can easily be achieved with an EIFS. Characteristics that control water infiltration include direct shedding off the surface, drainage



channels within the system, and a water-resistant membrane against the sheathing. “The water, in all cases, is directed away from the building with flashing and weep screeds,” says Chinnock.

The Façade Group’s Altenhofen emphasizes the need for meticulous design with EIFS. “Edges, openings, and penetrations have to be very carefully detailed for durable performance. Without paying attention to every detail, even down to mounting a light or sign, there can be very quick localized failure of the wall.” When carefully detailed, he adds, “In our experience, EIFS seldom have problems.”

While EIFS are generally quite serviceable when installed as drainage-plane assemblies, many Building Teams prefer the level of performance offered by back-ventilated, drained-cavity (BVDC) types of EIFS walls or rainscreen assemblies.

EIFS products come in many colors and finishes, including smooth, patterned, and textured options. A typical EIFS exterior may require repainting or refinishing every five to 10 years, and it may be a challenge to match the color and finish for repair work. The category also continues to battle notions that EIFS constitute a “cheap” finished building product, says Chinnock, mainly due to poor design and installation in some low-quality buildings.

Stucco. In general, stucco is durable, cost-effective, and aesthetically versatile for a range of building types. As a simplified weather barrier system, a stucco wall must be able to shed all elements, as there is little opportunity for ventilating and drying out, according to Chinnock. The joints must be mechanical—such as reglets or flashing—and expansion joints are specified at regular intervals, typically every 144 sf or 12 feet on center and at all floor lines. “This can be limiting to the aesthetics of the wall design,” Chinnock adds.

“All of the control joints required for stucco are disturbing for some architects,” agrees Altenhofen. “And developing details for continuous insulation with stucco are more difficult.”

As with EIFS, it can be difficult to match stucco colors and finishes during repair jobs. Typical wall specifications call for refinishing every five to seven years. There may also be performance considerations, says Construction Consulting International’s Blackburn. For instance, unexpected cracking can occur in stucco installed on metal-stud-framed walls. “We regularly investigate stucco defects of this type,” Blackburn adds. Hairline cracks rarely present a cause for concern, however, and they are typically not a warranty defect (depending on how the air and water barriers are installed behind the stucco).

Brick and masonry. Very common cladding materials, brick veneer and masonry veneer deliver durability at a reasonable cost, although maintenance is required over time. Historically used in solid, multiple-wythe walls, brick and masonry have evolved into a plethora of sophisticated systems combining veneer walls with drainage cavities attached to interior structural concrete masonry unit (CMU) structures or metal stud-frame assemblies, or a combination of the two.

Blackburn stresses the importance of installing air and water barriers on the interior wall system’s exterior face, with flashing and adequate weeps to drain water to the outside. Done correctly, the resulting brick and stone cladding systems are capable of delivering

a long serviceable life, with some lasting for many decades. At the same time, the longevity and durability of thin-stone wall claddings are very much dependent on the performance of the mechanical supports and anchors. “We have investigated walls where the anchors were failing or the attachments into the stone caused the stone to fracture,” Blackburn says.

Terra cotta. Also offering long life and durability, terra cotta lends a unique palette of smooth textures and ruddy or brownish-orange colors as a cladding material. Engineered terra cotta façade systems generally work well and provide good protection against the elements. “Terra cotta is currently a popular treatment because it is an attractive, aesthetically pleasing product,” says A.J. Giglio, a Project

FLAMES OF CONTROVERSY: meeting NFPA 285

As Building Teams work to achieve high insulation levels, the International Building Code recently raised the profile of a little-known standard called NFPA 285. This standard—Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components—has been around for some time. But its increasing list of test triggers, its inclusion in the IBC, and the fact that it is a full-assembly test—all combustible components within a wall assembly must be tested as a group—have made NFPA 285 a thorny problem for Building Teams and manufacturers alike.

Foam plastic insulation and water-resistive barriers, EIFS, metal composite materials, fiber-reinforced plastics, and high-pressure laminates—among other products—require NFPA 285 testing to ensure limited vertical and horizontal flame propagation in the event of a fire. “Requirements for NFPA 285 testing are putting a lot of limits on wall-system specification and risk increased construction prices for building owners,” explains Shepley Bulfinch’s Jonathan Baron, a BETEC board member and former BEC-Boston chair. Because a full assembly must be tested, without substitutions, architects are starting to write proprietary specifications, risking inflated bids. “Alternately, architects can specify new assemblies appropriate to their project conditions, but building owners must pay tens of thousands of dollars for a test,” he says.

Some design teams are turning to noncombustible materials—for example, mineral wool in place of foam insulation. These changes may adversely effect performance. For example, though mineral wool is considered a fairly effective solution, Richard Keleher of Thompson & Lichtner points out that it has a tendency to absorb water at ledges. In addition, R-values are somewhat compromised, with mineral wool delivering R-4.2 per inch, compared with R-5 for extruded polystyrene. “Reduced insulation values mean increased energy consumption or require the addition of insulation within stud cavities,” notes Baron.

Another alternative is bringing in a third-party consultant to furnish an engineering judgment letter vouching for the fire safety of a specific assembly. “Many building officials are sympathetic to the use of other insulations that have performed well in the past, especially since there are few recorded incidents of damage to exterior walls from fire,” says Baron.

Some experts are questioning the standard’s usefulness. “I don’t know that our buildings are any safer for all of this,” says David Altenhofen of The Façade Group. “The insulation, membrane, and accessories for roofing assemblies can be safely selected by code without a test for the entire assembly. I do not understand why the same can’t be done for wall assemblies.”

Executive and Building Envelope Specialist with Gilbane Building Company (www.gilbaneco.com). “We have done many successful installations of terra cotta, including K-12 schools and universities. It requires planning, as it can be more labor-intensive to lay out.”

The Façade Group’s Altenhofen points out that many cladding systems involving terra cotta are marketed with completely open joints and incorrectly labeled as “rainscreens.” “I believe the term ‘rainscreen’ gives some false sense of heightened performance, since rainscreen assemblies, when properly detailed, should stop nearly all water penetration at the line of the cladding. Open-grille-type cladding layers do not stop enough water penetration, so there may be a great deal more water at the air barrier and water-resistive barrier layer.” The result is greater risk of water leaking into the building. Such assemblies should really be categorized as barrier walls rather than high-performing rainscreens, in Altenhofen’s opinion.

Some façade consultants don’t recommend open-grille systems for anything higher than three stories. In addition, the panels move quite a bit with thermal cycling, so attachment details must be carefully designed to accommodate the full range of expected movement.

Fiber-cement panels. Breaking away from its niche as a siding material, fiber cement panel (FCP) claddings are increasingly being used as rainscreen systems, similar to terra cotta and high-pressure laminate (HPL) panels. “The new uses of FCP product appear to be durable,” says Blackburn, “but the method of attachment and support is critical to the longevity.” As a rainscreen system, the FCP materials are usually installed on wood battens or metal hat channels over a weather barrier, which then goes over the sheathing. “It is ideal to have the insulation over the sheathing to create a continuous thermal barrier, but there must be sufficient space between the insulation and FCP to allow ventilation,” says Chinnock.

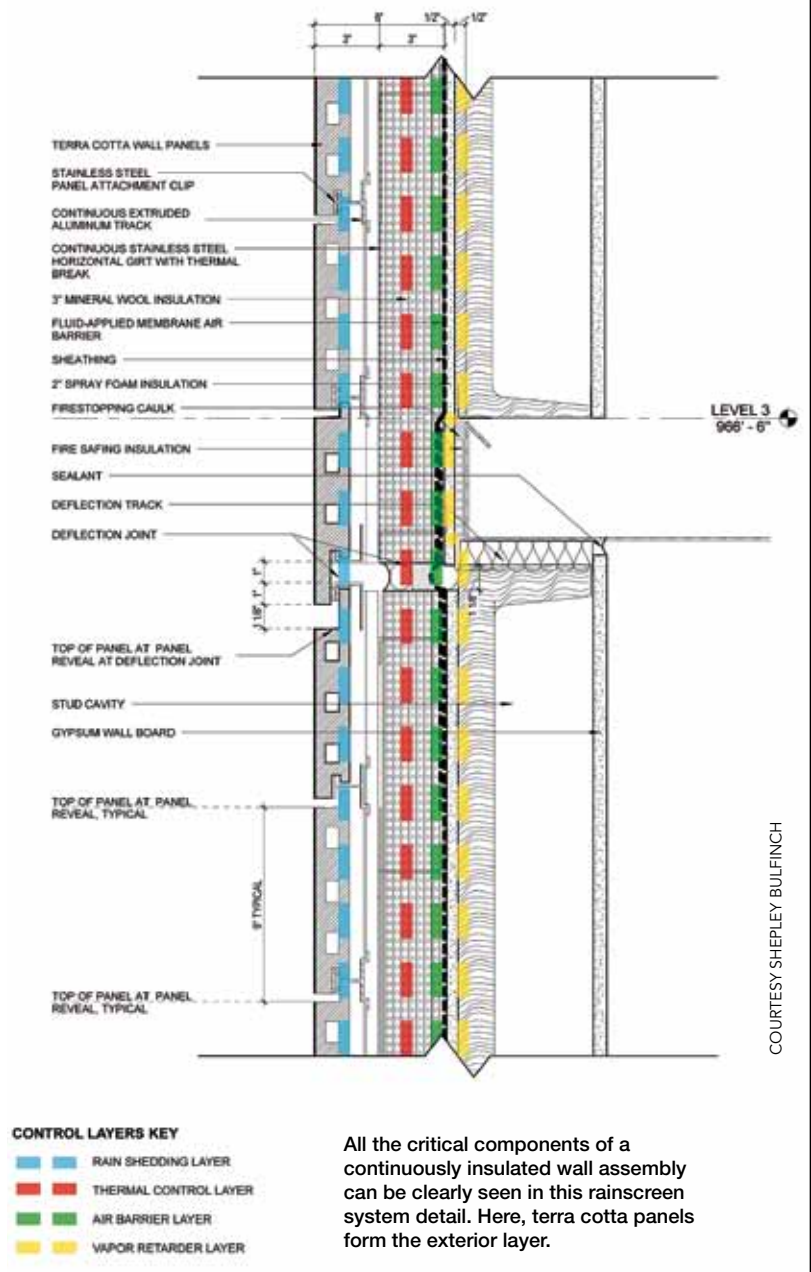
One drawback, according to Chinnock, is that flashing must be installed at every floor line—potentially detracting from the aesthetics of the panel layout. The panels can be difficult to repair, as well. The pre-finished pieces are hard to touch up, and a cracked or chipped panel can be difficult to replace.

Beyond rainscreens, FCP can be used as a standard reglet trim system, custom trim pieces, or open joints. If installing an open-joint design, Chinnock recommends UV tape for the water-resistant barrier behind the joints.

High-pressure laminate panels. HPL panels—though mainly manufactured in Europe—are increasingly showing up in American rainscreen applications. Air and water barriers are installed on the supporting wall behind. As with FCP, performance depends on the method of attachment, as well as proper installation of air barriers and water barriers.

There’s another similarity to FCP, says Thompson & Lichtner’s Keleher: Since there is no visual and ultraviolet baffle at the open joints, a dark-colored drainage plane sheet is necessary over the insulation in the drainage cavity behind the cladding. “This is to prevent the insulation from showing and, for mineral wool insulation, to keep the insulation from getting wet,” he says. “It is critical that this drainage plane be vapor-permeable, to allow the insulation to dry out if it does get wet.”

RAINSCREEN DEFLECTION JOINT



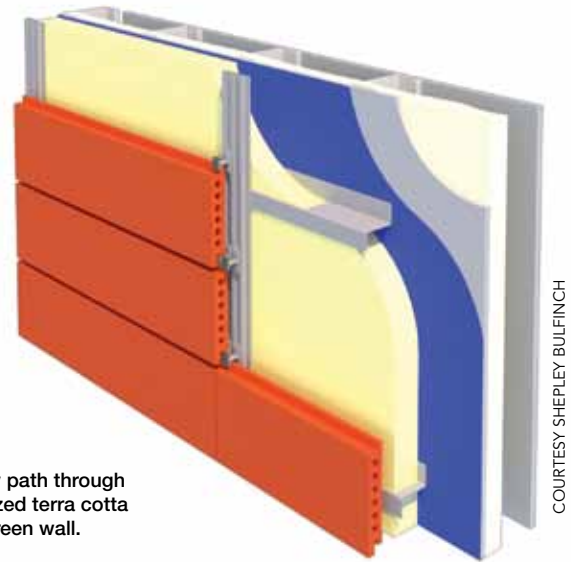
THE RUNDOWN ON RAINSCREENS

Over the past couple of decades, construction experts such as B.R. Fries’ Brody have observed a shift from veneers to rainscreen systems, which ultimately puts much more emphasis on the design, coordination, and construction of the back-up wall. In fact, Keleher recommends designing all veneers as rainscreens, using what the Europeans call two-stage weather-tightening. This type of design includes the rainscreen with drainage behind, insulation, an air barrier, and, if required based on climate, a vapor barrier.

“The rainscreen requires the wall behind it to perform as if the rainscreen weren’t there,” says Giglio. “As a result, the degrees of tolerance for design, coordination, and installation are all reduced, and that’s why the exterior envelope has to be treated as a system—a system just as important as the HVAC systems engineered for the building.”

To promote the design and construction of an effective rainscreen, Gilbane’s practice as a CM is to team up with the designers and building owner early on in a project to identify design intent and performance requirements, according to Giglio. These early coordination meetings also help establish relationships with vendors, so the entire Building Team can run through a process checklist to identify compatibility, sequence of installation, and parties who are certified to install the components.

Essentially, a well-designed rainscreen provides two lines of defense: a weather-shedding outer barrier and a primary inner drainage plane with the air, vapor, and moisture barrier. These wall systems are particularly important in climates with lots of rainfall or periodic heavy rains because they can keep insulation dry while allowing the cavity to dry out. “An effective inner air barrier creates an air pressure within the cavity that is equal to that of outside air, which reduces the force driving water into the building, and thus promotes drainage out through flashing and weeps,” explains Mark Finneral, AIA, a Director in the Boston office of Shepley Bulfinch and an active member of BEC-Boston. To ensure that the system works properly,



Airflow path through a unitized terra cotta rainscreen wall.

COURTESY SHEPLEY BULFINCH

says Finneral, vent openings must be adequately sized, the cavity should be compartmentalized to equalize pressure differences, and flashings and weeps should be properly detailed to minimize thermal bridging at the veneer support members.

Blackburn adds that the flashings and waterproof membrane must be sealed together so water will be contained during high wind conditions when water cannot drain from the wall cavity.

Rainscreens’ advantages over conventional enclosure systems include enhanced control over water penetration and air infiltration, and the ability to put lots of insulation in the air cavity where condensation is not a concern.

Rainscreens also offer some advantages in the area of wall durability, according to Phil Kabza, FCSI, CCS, AIA, a Partner with SpecGuy Specifications Consultants (<http://specguy.com>). All kinds of barrier walls rely on high-performance sealants to accommodate their movement, which means that every joint has a built-in expiration date. “With today’s excellent sealants, that date may be 20 years from now, but mark your calendars,” Kabza says. “Rainscreens protect against environmental stresses in layers so that the most sensitive materials—membranes and sealants—encounter less UV and thermal impact and can be expected to last much longer.”

While some projects may call for simpler barrier or mass walls, Altenhofen says, these solutions might not deliver the same long-term durability as a back-ventilated drainage cavity wall or rainscreen assembly. If any of the following conditions are present in a project, Altenhofen strongly recommends a BVDC or a pressure-moderated rainscreen:

- Larger wind loads due to building’s height or location (for instance, near a coast).
- Hospital or museum applications, where extremely reliable protection of the building interior against water infiltration is required.
- The owner wishes to reduce the risk of future repairs due to water infiltration.

“The more a building’s walls are subject to environmental stresses

DEFINING THE RAINDSCREEN: community works toward clarity

Because the term “rainscreen” is so freely used in the design and construction industry, and often means different things to different people, the American Institute of Architects is attempting to standardize its definition for improved communication. In a recent article in *Technique*, the newsletter of the AIA’s Technical Design for Building Performance Knowledge Community, two enclosure experts offer some valuable advice (<http://bit.ly/1ITnNOG>). The experts—David Altenhofen, AIA, Building Enclosure Consultant, Manager, The Façade Group, and Michael J. Lough, AIA, Founder of Integral Consulting—offer the following helpful definitions:

- **Back-ventilated drained cavity wall assembly.** A drained cavity wall assembly with opening distributed from bottom to top to allow for air movement between the water control layer and the water shedding layer.
- **Pressure-moderated rainscreen assembly.** A back-ventilated drained cavity wall assembly with the air cavity compartmentalized so air pressures between the exterior and air cavity are approximately equal to control the final force that causes water to move through an opening in the watershed layer.
 - **Rainscreen.** The cladding layer that provides the first line of defense against rain penetration in a pressure-moderated rainscreen assembly.
 - **Grilled barrier wall assembly.** A wall assembly with a cavity and a grille over a barrier-type water control layer. The “grille” is any cladding system that does not effectively control water through the joints—ergo, any open-joint cladding. If a secondary cladding layer is added behind the grille or open joint cladding, the wall can be a rainscreen assembly.

and the longer a building will be in service, the more useful is the added investment in rainscreens,” Kabza agrees.

ENSURING PROPER DRAINAGE

With all cladding types, Building Teams must ensure that envelope assemblies are properly designed to drain water so that the wall can fully dry. “One of the most common problems we see is that non-flanged windows, which frequently require a watertight seal at the outside face, are instead detailed with a seal to the cladding,” says Altenhofen. “This allows for air and water penetration around the sides of the frame.” Detail the wall to ensure a seal between the window edge and watertight air membrane. This may require some extra sheet metal trim or blocking.

Construction Consulting International’s Blackburn also recommends clearly specifying the size and spacing of the drainage and ventilation weeps, both horizontally and vertically, and indicating the continuity of the drainage plane waterproof membrane, and its sealing to the various flashings at the wall base, penetrations, fenestrations, and terminations.

Finneral adds that through-wall flashings should be placed above all wall openings, at all horizontal veneer supports, at horizontal material changes, below window sills, and at the base of exterior walls. “Flashings are generally two pieces, exposed and concealed, which overlap and are sealed to each other within the cavity,” he says. “The inner flashing passes through the insulation and is stripped into the wall membrane with a strip of membrane material. All flashings are set in sealant and weeped above.”

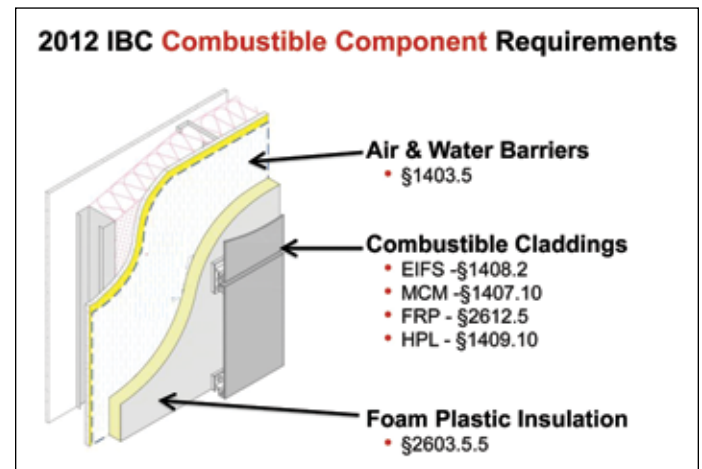
When working with brick veneer, Kabza, a member and past chair of the AIA MasterSpec Architectural Review Committee and founder of Charlotte-BEC, recommends cleaning the air spaces with bottom and top vent holes, not just the weepholes, to reduce efflorescence, promote drying, and reduce inward vapor pressure, especially in humid climates. In addition, transition flashings between the panel-clad wall and brick veneer always require careful detailing.

Considering the wall assembly within the greater context of the building envelope, Sue Klawans, Gilbane’s VP and Corporate Director of Operational Excellence and Planning, points out that while water flows down the cavity, wind and storm events drive water uphill. This phenomenon can exert pressure to drive water into the interior. Buildings’ HVAC systems are often balanced for negative pressure, which could tend to exacerbate this process. Building Teams should follow a comprehensive building envelope success checklist, including flashings, air and vapor barriers, connections at dissimilar materials, HVAC design intent, end dams, connection to roof, and connection to the foundation.

“Our checklist is extensive, and it’s a good reminder that an exterior envelope is a system just as complex and crucial as the HVAC system or power system,” Klawans says.

ACHIEVING DESIRED R-VALUES

In addition to making sure that all membranes are properly sealed and that the drainage system is adequate, avoiding thermal bridging



COURTESY DUPONT BUILDING INNOVATIONS

Now that the International Building Code has adopted NFPA testing standards for combustible components in wall assemblies, the systems illustrated here all require flame propagation testing.

is crucial. The biggest problems involve elements that support the cladding, which run the greatest risk of becoming thermal bridges that can significantly compromise R-value.

The traditional approach has been the use of Z-furring, with insulation placed between the Zs. This design renders the insulation non-continuous, which violates current code requirements and reduces R-values by as much as 50%, according to Jonathan Baron, AIA, LEED AP, Director, Shepley Bulfinch.

The Façade Group’s Altenhofen agrees: “The use of continuous Z girts aligned with the metal studs of the back-up wall to support cladding is a common solution, but a very poor one.”

Fortunately, newer products are available to reduce bridging. For example, bracket systems that reduce support to isolated points can significantly boost thermal performance by only compromising R-values by a small percentage. Interruptions in the insulation at the wall frame members can also reduce insulation levels; installing continuous insulation on the wall frame exterior is a good strategy.

When dealing with brick veneer, the brick ties only cause relatively small thermal breaks. However, the shelf angle and lintels will create large thermal breaks. “Continuously supported masonry shelf angles should be avoided by using cantilevered shelf angles with continuous insulation behind between the support attachments,” says Blackburn.

For barrier walls, all joinery internal to the system, as well as the building expansion and deflection joints, must be properly detailed, according to Shepley Bulfinch’s Finneral. “Develop details that minimize thermal bridging at veneer support structure, and carefully select and layer underlayment materials to avoid creating multiple moisture/vapor barriers which could trap water within the wall,” he explains.

When planning for a mass wall, the Building Team should consider the density and absorption rate of exterior materials, the amount of insulation on the interior, and the resulting dew point location within the wall. In addition, the designer should have a good understanding of how the wall will dry out when it gets wet.

SpecGuy’s Kabza points out that wall assemblies are complex

systems pieced together by perhaps a dozen or more trades, often using products from several dozen manufacturers. Thus there is plenty of potential for all aspects of performance, including thermal performance, to be compromised.

B.R. Fries' Brody emphasizes that team collaboration can help avoid thermal-bridging problems. "Construction managers have made great strides to coordinate their work and improve upon the thermal anomalies." In addition, he notes, air barrier installers and inspectors make great efforts to ensure compatibility of their products, and manufacturers have developed thermally-improved fasteners for rainscreen cladding that reduce thermal bridging and moisture penetration.

DOUBLE-WALL AND OPERABLE FAÇADES MAKING INROADS IN THE U.S.

Quite popular in Europe, the concept of a double-wall (or double-glazed) operable façade is slowly making its way to American shores. Several factors need to be in place to justify the expense of building and calibrating the sophisticated system. The beauty of the technology is its ability to exploit nature's gifts of natural ventilation and solar heat gain. The façade is made up of two layers: an outer curtainwall and inner glass pane, with an interstitial space that provides a thermal buffer. The outer and inner glass windows/walls, and often interior or exterior shading devices, are opened or closed based upon the time of day and season.

For instance, in winter, the sun heats up the air in interstitial space, which can then be released into the building by opening the internal glazing, providing free heating. During hot summer months, the internal pane stays closed and the exterior glazing is opened, releasing heat and helping to keep the interior cool. On moderate days, both glass panes can be opened to optimize natural ventilation and minimize HVAC requirements.

Josef Gartner GmbH, in collaboration with the Fraunhofer Institute, has developed a closed-cavity façade composed of a triple-glazed panel or insulating glazing unit (IGU) as the interior glass and a single glass pane and shading device on the exterior. The cavity is sealed and conditioned with a small amount of dry air to prevent condensation. Solar heat gain inside the cavity dissipates through the single pane, and the sealed space delivers a high level of thermal protection during winter and summer.

"Double-glazed facades are popular in Europe for several good reasons," says Altenhofen. "The climate is milder, the occupants accept a broader range of temperatures for comfort, operable windows are required even on high-rise buildings, and energy costs are higher."

These factors may not apply for some projects in the U.S., where it can be more difficult to make a case for the technology. "Long before we spend that kind of money, we should be doing the basic things like using triple glazing and sun-control devices, and ensuring better control of air leakage," suggests Keleher.

Gilbane's Giglio does see double-wall facades starting to take hold in America; his company is currently involved in a number of relevant projects.

Consulting firm Buro Happold has researched double-façade

technology, performing dynamic thermal modeling to show estimated energy savings and projected payback periods for varied systems in different climates and orientations (www.cibse.org/pdfs/8cstribling.pdf). The firm reported average HVAC energy consumption savings of 27% in Las Vegas and 23% in London, though not all locations were as impressive. The report encourages Building Teams to consider climate, construction type, detailing, and cost when determining the feasibility of double façades. In addition, the report offers the following guidelines:

- A double façade offers the most energy-saving potential on the south and southwest orientations.
- Extreme climates provide more opportunity for energy savings.
- Energy savings can range from 10% to 50% of HVAC energy, and cost payback can range from 30 to 200 years based on today's energy prices.
- Energy prices will also vary greatly over the life of the building and should be considered.

Altenhofen concedes that double façades may be a good solution in a few cases—notably, when a large amount of glass is desired for a very special view, and where energy savings are very important. "Otherwise, it is possible to deliver better energy performance at lower cost with other assemblies," he says.

WALL DESIGN GUIDELINES

Because cladding assemblies and building enclosures are such complicated systems, designers could benefit from more industry design resources and guidelines. Some good resources do exist, including the National Institute of Building Sciences' Whole Building Design Guide and Building Envelope Design Guide, materials and workshops provided by NIBS' Building Enclosure Councils, the Air Barrier Association of America's network of experts and training programs, and authoritative texts such as John Straube's latest book "High Performance Enclosures." Many architects would love to see more.

Klawans points out that the rate of change in details, codes, material formulations, and choices exceed the industry's ability to develop and agree on standard, reliable details and processes. Thus it is essential for the Building Team to pool collective expertise, from early design through construction.

"To stay on the cutting edge of building envelope science, Gilbane developed its own checklists and processes and started a Building Envelope Peer Group, with representatives from our offices across the country," Klawans says. "It's essential to have disciplined processes and to continually advance our knowledge sharing and expertise through living checklists, webinars, group meetings, our internal website, and our internal ask-the-specialist database." +

> EDITOR'S NOTE

This completes the reading for this course!
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