Feature

Thin Brick Insulated Precast Wall Systems: A High-Performance Solution

By Jim Schneider, LEED AP

ARCHITECT LUDWIG MIES van der Rohe once famously said, "Architecture starts when you carefully put two bricks together. There it begins."[1]

PHOTO COURTESY OF WELLS.

Figure 1. *Fast and efficient, precast concrete sandwich wall panels with thin brick faces can be utilized on a variety of building types.*

There is elegance in that statement, and certainly the humble masonry brick has been an important part of construction across the world for centuries or longer. Tastes and techniques change, but the warm aesthetic of brick always weaves its way into the design of many types of structures.

But what if, instead of putting those bricks together one or two at a time, as Mies van der Rohe mused, an entire wall section could come together at once? It can, and using precast, prestressed concrete wall panels with thin brick facing is an efficient solution on projects that want the look of traditional masonry but with the speed and performance today's construction market demands (**Fig. 1**).

A precast concrete wall panel with an embedded thin brick face begins with a form liner that establishes the coursing pattern sought for the project. Form liners are the grid in which the thin brick is placed while in the precast concrete mold. They set the overall aesthetic of the precast concrete panel (**Fig. 2a** and **2b**).

The selected thin brick must tightly fit into the plastic, rubber, or foam form liner to comply with Precast/Prestressed Concrete Institute's (PCI's) thin brick specifications.[2] A loose-fitting brick can cause misalignment and will allow for the concrete slurry to migrate to the thin brick face during precast casting. Many thin brick manufacturers apply a wax coating on the thin brick face to prevent the concrete from hardening on the brick's face. The wax coating simplifies the final cleaning process.

It is important to note that the thin brick used in precast concrete wall panels is an extruded clay and/or shale product and fired

Interface articles may cite trade, brand, or product names to specify or describe adequately materials, experimental procedures, and/or equipment. In no case does such identification imply recommendation or endorsement by the International Institute of Building Enclosure Consultants (IIBEC).

PHOTO COURTESY OF INNOVATIVE BRICK SYSTEMS.

Figure 2a. *Thin bricks are placed in form liners like the one pictured here, before concrete is placed. This sets the coursing pattern for the finished wall.*

PHOTO COURTESY OF INNOVATIVE BRICK SYSTEMS.

Figure 2b. *Returns are cast into precast concrete thin brick panels by utilizing specialty form liners and bricks, as shown in this photo.*

in a kiln. Some manufacturers create thin brick from full-sized bricks, and others extrude thin bricks in their final form. Extruded thin brick requires 75% less raw materials, natural gas, and transportation. Whatever the production technique, thin brick is available in most any color or texture as traditional brick.

One of the differences between a precast concrete wall system and a hand-laid brick wall system is the bonding material. Brick facades are constructed using 750 to 2,500 psi (5.2 to 17.2 MPa) mortar, and precast concrete uses 5,000 psi (34.5 MPa) concrete. Instead of a cavity wall system behind the masonry facade, there is a durable precast, prestressed concrete barrier wall (**Fig. 3**). Often, thin brick is seen on insulated sandwich wall panel construction. This type of assembly is made up of an interior wythe of precast concrete and an exterior wythe of precast concrete, with a layer of continuous insulation sandwiched in between. Non-conductive ties (made from carbon fiber or other non-metallic materials) hold the assembly together and prevent thermal bridging. This type of sandwich wall panel can be a single-solution system to serve as a vapor retarder and air barrier and manage thermal flow.

As enclosure performance requirements continue to rise and the demand for buildings that operate beyond code grows, precast concrete sandwich wall construction with thin brick can be an extremely attractive option for many projects seeking an energy-efficient solution that retains the look and feel of traditional brick construction.

Figure 3. *Traditional brick facades use 750 to 2,500 psi (5.2 to 17.2 MPa) mortar between bricks. In a precast concrete thin brick wall assembly, the space between the bricks uses 5,000 psi (34.5 MPa) concrete, which is stronger and more durable.*

BEHIND THE WALL

Putting aside the look of the facade for a moment, let's consider what is going on behind the wall. Traditional brick construction is typically paired with a backup wall assembly, like a cavity wall. Basically, two walls are built parallel to each other with a space between them and ties or blocks holding them together.[3]

Like the exterior brick wall itself, cavity walls take a great deal of skill and planning to build properly. The assembly must be carefully

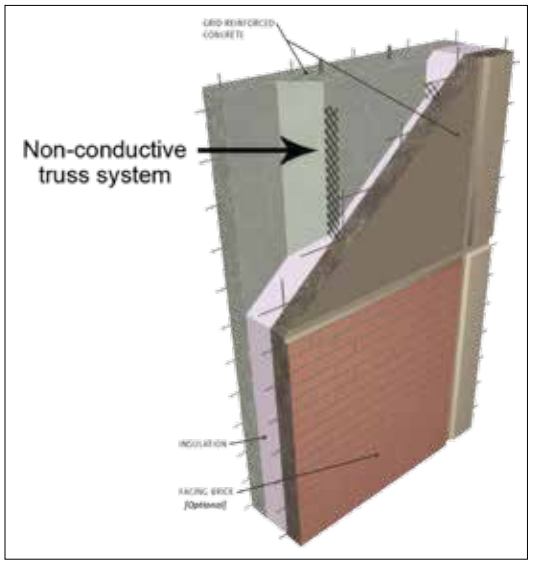

Figure 4. *This cutaway view shows the different components of a precast, prestressed concrete sandwich wall panel.*

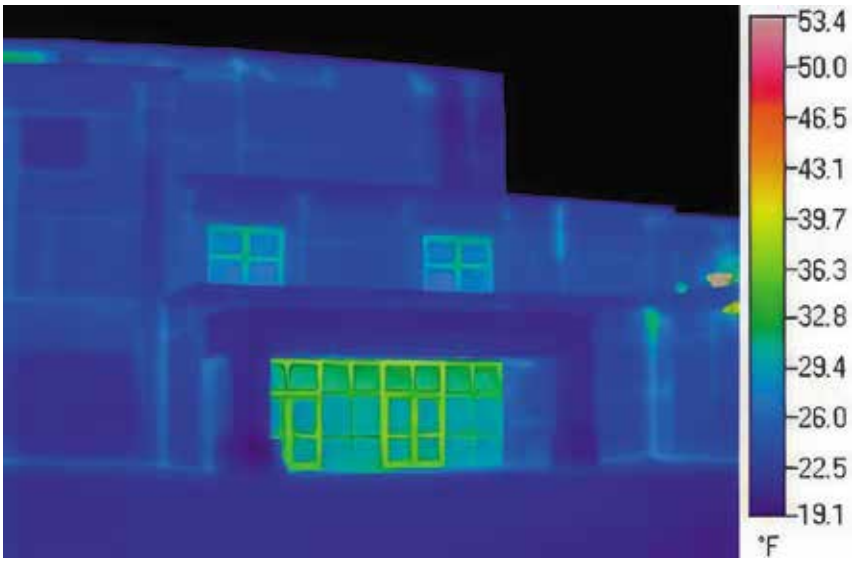

Figure 5. *This thermal image of Centralia High School in Illinois shows no significant thermal energy escaping through the precast sandwich wall system. It creates an efficient thermal envelope.*

designed to account for the movement and transfer of air, moisture, and heat. Improper design and assembly can result in poor enclosure performance and even issues like dirt, water, or mold collecting in the cavity.

In a precast concrete insulated sandwich wall assembly with a thin brick face, the wall backing up the brick facade is made up of two wythes of precast, prestressed concrete with a layer of continuous insulation sandwiched between. The wythes are typically connected by a series of ties or mesh made from a non-conductive material (such as carbon fiber or fiber composite) to eliminate thermal bridging (**Fig. 4**).[4]

Using metal pins or ties of any kind, as can be the case in some traditional brick cavities, allows thermal energy to move through the assembly. Any metal will create cold spots or short circuits that impact the thermal efficiency of the assembly,[4] per ASHRAE 90.1. As the thermal imaging in **Fig. 5** shows, a precast concrete sandwich wall panel providing continuous insulation free of thermal bridges prevents thermal energy from passing through.

Precast concrete insulated sandwich wall panels are generally classified as composite or non-composite based on design methodology and connection devices used between the two concrete wythes. Composite panels work together as one wall to carry load, while non-composite panels work independently, often with the interior wythe being thicker to carry load, while the exterior wythe with the thin brick is architectural (**Fig. 6**).

Composite panels of a given total thickness will have nearly the same stiffness and strength as solid panels of the same thickness. Non-composite panels will have roughly the same stiffness and strength as the sum of the stiffness and strength values for the individual concrete wythes.

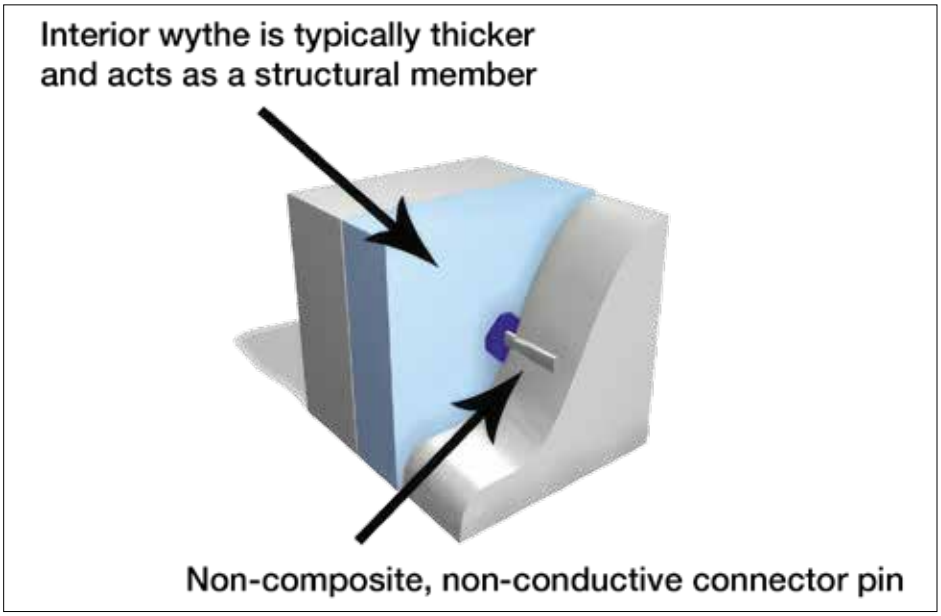

Figure 6. *This drawing shows the makeup of a non-composite sandwich wall, using a non-conductive pin to eliminate the potential for thermal bridging.*

For similar panel geometries, partially composite walls have stiffness values greater than non-composite panels and less than composite panels and strength magnitudes greater than non-composite panels and less than or equal to composite panels.[5]

Precast concrete sandwich walls (with or without embedded thin brick) are a durable, effective option for the design of high-performance enclosure systems. These factory-produced panels provide edge-to-edge insulation without thermal bridges and can vary in thickness to meet whatever *R*-value is required. The assembly thickness can vary to accommodate the required insulation performance. Backer rod and sealant are used at the joints to preserve the integrity of the enclosure.

While presenting a classic brick appearance so often sought after on schools, mixed-use buildings, offices, or other building types, these thin brick wall panels conceal a pre-engineered,

efficient, and effective enclosure system that can provide superior performance for decades (**Fig. 7**).

AIR AND MOISTURE

According to the *International Building Code*, a material or membrane with a permeance of 1 perm (57 ng•s•m^2•Pa) or less is a vapor barrier; less than 0.1 perms (6 ng•s•m^2•Pa) is considered vapor impermeable and between 0.1 and 1 perm is considered semi-impermeable.

Precast concrete can be considered a semi-impermeable vapor retarder in thicknesses of 3 in. (7.62 cm) or more. A low water-cement ratio, such as that used in precast concrete wall systems, results in concrete with low permeance.[6] Properly applied, 1 in. (2.54 cm) or more of rigid extruded polystyrene board or 2 to 3 in. (5.08 to 7.62 cm) of expanded polystyrene serves as its own vapor barrier. Together, the concrete and insulation in the precast concrete sandwich wall assembly effectively serves as a vapor barrier,[7] which ASTM defines as "a material with a permeance (water-vapor transmission rating) of 0.1 or less."

Air is another element to manage. Described as infiltration and exfiltration (air leakage into and out of a building, respectively), air moves through cracks or joints between infill components and structural elements, around windows and doors, at the top and bottom of walls, and at openings for building services such as plumbing.

Approximately 20% to 50% of air leakage occurs through walls.[8] Infiltration and exfiltration can be a major source of energy loss in buildings. An air barrier and vapor retarder are both needed in a properly designed building enclosure. An insulated precast concrete sandwich wall with thin brick can do both of those things, as well as manage thermal transfer, in one quick-to-install system.[8]

While a traditional brick assembly and cavity wall can accomplish those things, it requires a great deal of design and coordination of trades, while a precast sandwich wall panel with thin brick is a single-source, one-component solution that addresses all these issues (**Fig. 8**).

OTHER ATTRIBUTES

Along with the performance benefits a precast concrete sandwich wall with thin brick can deliver to the building enclosure, there are other reasons to consider this type of construction on projects looking to incorporate masonry (**Fig. 9**).

- **Cost Efficiency.** Precast concrete facade components are often more cost-effective than other building materials due to their efficient manufacturing process. Once molds are created, concrete panels can be mass produced in a factory setting at a lower cost than the labor-intensive process of laying brick or stone.
- **Speed of Construction.** Precast concrete panels are manufactured off-site and then delivered to the construction site. This approach significantly speeds up the construction process compared to masonry, where each unit must be individually placed and set.
- **Site and Labor Efficiency.** The off-site nature of this construction dramatically reduces the impact to the site and requires less labor. The panels arrive ready to erect, so there is no

PHOTO COURTESY OF WELLS.

Figure 7. *Precast insulated sandwich wall panels can utilize thin brick in a variety of colors and coursing patterns to achieve a wide range of looks.*

PHOTO COURTESY OF CLARK PACIFIC.

Figure 8. *Precast sandwich wall panels arrive at the jobsite ready to erect, which saves on labor and requires little space for staging or storage.*

PHOTO COURTESY OF CLARK PACIFIC.

Figure 9. *Today, just about any look that can be achieved with traditional brick construction can be done with thin brick.*

PHOTO COURTESY OF WELLS.

Figure 10. *Precast/Prestressed Concrete Institute-certified producers of precast, prestressed concrete components are valuable assets to the design team. Bringing them to the table early in the project is encouraged.*

space required for staging or storage. For that reason, precast panels are ideal for tight urban jobsites with little room for access. Since most of the work is done in the plant, usually a crane and minimal crew are all that is required for installation.

- **Design Flexibility.** Able to be molded into various shapes, sizes, and textures, precast concrete can make possible more intricate and customized designs than other building materials, which are often limited to standard sizes and patterns.
- **Quality Control.** Since precast concrete panels are produced in a controlled factory environment, there is more consistency and quality control compared to masonry, where variations can occur due to on-site conditions and the skill level of the masons.
- **Durability and Maintenance.** Precast concrete facades are very durable and require less maintenance than traditional brick construction. A thin brick precast concrete wall does not require tuckpointing and is less susceptible to weathering, erosion, and the growth of moss or lichen.
- **Exterior Aesthetics.** In the past, one of the criticisms of thin brick precast concrete wall systems was that there were limited options for color and texture of thin brick and that it oftentimes looked unnaturally straight and "too perfect." Today, just about any look that can be achieved with traditional brick construction can be done with thin brick. There are form liners designed to provide a more natural look and even tumbled thin bricks that are deliberately weathered to match older masonry on historic renovations.
- **Interior Finish.** Precast concrete sandwich walls can provide a finished interior wall as well, minimizing the use of materials. The interior wythe can be finished to appear like drywall with the durability of block in applications like gymnasiums, back of house in convention halls, etc.

PCI STANDARD

Embedded thin brick in precast concrete wall systems must meet PCI specifications and standards.[2] These cover dimensional tolerances, water absorption standards, pull-out bond standards, freeze-thaw resistance, and warpage requirements.

When using a thin brick system, refer to the *PCI Specification for Embedded Clay Thin Brick* for all the required standards. If a thin brick does not meet or exceed these standards, then failures in the precast concrete system could occur.[2]

Every project has its own unique requirements and demands, and precast is, by its nature, a custom-engineered, individualized solution. PCI-certified precast concrete producers are a valuable resource and will work to ensure that the look and performance of the wall system live up to the expectations of the design. Bringing the precast concrete producer on early as part of the project team will enhance the efficiency and effectiveness of the solution (**Fig. 10**).

Precast concrete thin brick facades offer a combination of cost savings, faster construction times, design versatility, quality control, durability, and efficiency that often surpasses traditional masonry methods. In a market where labor is at a premium, schedules are tight, and demands for energy-efficient, durable, resilient construction methods are growing, precast concrete is a worthy consideration for owners, designers, engineers, and enclosure consultants.

REFERENCES

1. Curtis, William JR. November 23, 2011. "Mies van der Rohe (1886-1969)." The Architectural Review. https://www.architectural-review.com/essays/reputations/mies-van-der-rohe-1886-1969.
2. Precast/Prestressed Concrete Institute (PCI). 2016. *PCI Specification for Embedded Clay Thin Brick*. Chicago, IL: PCI. https://www.pci.org/GuideSpecifications.
3. Masonry Advisory Council. 2002. *Cavity Walls: Design Guide for Taller Cavity Walls*. Park Ridge, IL: Masonry Advisory Council. https://masonryadvisorycouncil.org/wp-content/uploads/2017/04/Masonry_cavity_walls_MAC.pdf.
4. Seshappa, Venkatesh, and Darryl E. Dixon. 2013. "Best Practices in Precast Insulated Wall Panel Design and Detailing." Paper presented at "2013 PCI Convention and National Bridge Conference," Grapevine, TX. https://www.pci.org/PCI_Docs/Papers/2013/Best-Practices-in-Precast-Insulated-Wall-Panel-Design-and-Detailing.pdf.
5. PCI. 2017. *PCI Design Handbook*. MNL-120-17. 8th ed. Chicago, IL: PCI.
6. PCI. 2007. "5.3.6.4 Condensation within walls and use of vapor retarders."In *PCI Architectural Precast Concrete Manual.* MNL-122. Chicago, IL: PCI. https://www.pci.org/BuildingEnclosureDesign.
7. PCI. 2007. "55.3.6.5 Air infiltration, exfiltration, and air barriers." In *PCI Architectural Precast Concrete Manual*. MNL-122. Chicago, IL: PCI. https://www.pci.org/BuildingEnclosureDesign.
8. Younes, Chadi, Abi Shdid, and Girma Bitsuamlak. 2011. "Air Infiltration Through Building Envelopes: A Review." *Journal of Building Physics* 35 (3): pp. 267–302. https://www.researchgate.net/profile/G-Bitsuamlak/publication/254114270_Air_infiltration_through_building_envelopes_A_review/links/563114c108ae0530378d038d/Air-infiltration-through-building-envelopes-A-review.pdf.

ABOUT THE AUTHOR

JIM SCHNEIDER

Jim Schneider *is executive director of PCI Mountain States, a chapter of the Precast/Prestressed Concrete Institute (PCI) covering Colorado, Idaho, Montana, Utah, and Wyoming. Schneider has been working with architects, engineers, and building professionals for nearly two decades. He has been the editor of several industry trade publications, including* Eco-Structure, Plumbing Engineer, PHC News, *and* Metalmag, *and currently is a regular contributor to several national and regional industry publications, including* Retrofit, Retrofit Home, Green Building & Design, Smart Buildings Technology, Ascent, *and* Colorado Design & Construction. *Schneider is a LEED AP, holds a certification in Corporate Sustainability from Cornell University and is passionate about efficient, sustainable design.*

Please address reader comments to chamaker@iibec.org, including "Letter to Editor" in the subject line, or IIBEC, *IIBEC Interface* Journal, 434 Fayetteville St., Suite 2400, Raleigh, NC 27601.