Why EIFS is Hot

Cladding performance in hot, humid climates

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Image courtesy ParexLahabra/Robert A. Aird, Inc.

ENERGY EFFICIENCY, ALONG WITH TEMPERATURE AND MOISTURE CONTROL, IS BECOMING THE MOST WIDELY USED BENCHMARK TO MEASURE SUCCESSFUL BUILDING PERFORMANCE. IN THIS RESPECT, EIFS CAN BE A HIGH-PERFORMING EXTERIOR CLADDING, ESPECIALLY IN HOT AND HUMID CLIMATES.

Control of the building envelope's thermal energy flow and moisture is critical for energy conservation, preservation of the building and its contents, and occupant comfort. The choice of exterior cladding and quality of installation are critical to achieving these principal benefits.

As part of a building envelope, exterior insulation and finish systems (EIFS) offer both energy efficiency and air and moisture control. EIFS has been widely used in North America since 1969. Its efficacy today is further validated by its inclusion in the 2009 *International Building Code (IBC)* and *International Residential Code (IRC)*.[1]

However, until now, it has been quite difficult for architects and specifiers to gain both a quantitative and qualitative understanding of the comparative hygrothermal (*i.e.* temperature and moisture control) performance of various wall assemblies. This stemmed from lack of real-world data collection and, consequently, led to misinterpretations by some of overall wall system performance as affected by:

- wind-driven rain;
- rainwater penetration;
- condensation;
- solar and night sky radiation;
- wind speed; and
- site/wall orientation.

A landmark 2008 study, completed by the U.S. Department of Energy (DOE), provided the first significant amount of real-world data related to performance of exterior claddings in hot, humid (*i.e.* Zone 3) climates.[2] The study, sponsored through DOE's Office of Energy Efficiency and Renewable Energy's (EERE's) Building Technologies Program (BTP) and EIFS Industry Members Association (EIMA), compared EIFS, drainage EIFS, brick, stucco, and cement-fiber siding.[3]

A natural exposure test (NET) facility was constructed near Charleston, South Carolina. The site featured panels with various wall claddings

Figure 1 **TEMPERATURE AND RELATIVE HUMIDITY**

Panel #	RH Low	RH High	Heat Flux Low	Heat Flux High
Brick Panel 15	35%	90%	-1.5	+1.9
EIFS Panel 5	42%	65%	-1.5	+1.3
Stucco Panel 12	60%	92%	-1.75	+1.5

Figure 2 **THE FLAW EFFECT**

Panel #	RH Low	RH High
EIFS Panel 2 (no flaw)	35%	75%
EIFS Panel 3 (with flaw)	40%	73%
Brick Panel 15 (no flaw)	38%	85%
Brick Panel 14 (with flaw)	45%	100%

This EIFS project employs a waterproof air barrier and a ready-mixed, acrylic-based, exterior wall finish. The decorative and protective wall coating is enhanced with advanced polymer technology and can be used over prepared concrete, masonry, and plaster substrates. Photo courtesy Sto Corp.

and assemblies. Each wall panel was fitted with sensors that provided a full profile of temperature, heat flux, relative humidity (RH), and moisture content.

The sensors collected data 24 hours a day, over a 30-month period, from January 2005 to May 2006 and June 2006 to June 2007. The data from each phase was then transmitted to researchers at Oak Ridge National Laboratory (ORNL) in Tennessee.

Reviewing the results

One of the study's goals was to determine which wall configurations performed best at managing moisture infiltration. Results indicated the highest levels for relative humidity occurred near the exterior sheathing and wood framing during winter months. This finding was not unexpected as insulation in the wall cavity creates cooler temperatures at the exterior sheathing. In addition, RH tends to increase as temperature falls.

One of the consequences of excess water vapor within a wall assembly is the increased possibility of condensation on cool surfaces inside the wall cavity. Moisture and/or liquid water can also enter the wall system through defects, poor design, and poor installation of interface materials. Uncontrolled moisture migration can result in significant material degradation when inadequately protected.

Orientation also affected relative humidity. The EIFS wall panel that faced northwest had up to 17 percent higher RH at the exterior sheathing compared to the same wall panels facing southeast.

The best performing wall configuration with respect to controlling relative humidity within the wall assembly was the EIFS panel with 102 mm (4 in.) of expanded polystyrene (EPS). The wall stud cavity was not insulated and no vapor barrier was installed on the interior.

Portland cement plaster (stucco) was found to have the highest relative humidity in both the summer and winter. The walls with stucco and brick showed high levels of RH at the insulation/gypsum interface during winter months (Figure 1).

The study is notable because it considered the building envelope in its entirety, while enabling examination of isolated materials and components of the exterior claddings. Another advantage of the process was wall exposure to real climatic loads.

In the study's second phase, a design 'flaw' was introduced to create the effect of moisture intrusion. The 610-mm (24-in.) standard K-gutter flaw was mounted above the panel that collected rainwater. The gutter length was sized to match the opening used in ASTM E 2273, *Standard Test Method for Determining the Drainage Efficiency of Exterior Insulation and Finish System (EIFS) Clad Walls*. Water from the flaw

Approximately 1670 m² (18,000 sf) of EIFS was used at Camden Potomac Yard, a luxury, multi-family, high-rise apartment building in Arlington, Virginia. Work involved finishing the cornices around the top of the building, as well as its ceiling.

Photos courtesy ParexLahabra/Robert A. Aird, Inc.

was channeled through a measurement device and flowed onto a weather-resistive barrier (WRB) in the wall assembly.

Each flawed panel had an identical corresponding panel without a flaw for comparison purposes. The flawed panels included:

- EIFS with notched trowel, vertical adhesive ribbons, liquid-applied WRB, no interior vapor barrier, and southeast orientation that represented the measured relative humidity on the face of the exterior sheathing;
- EIFS with notched trowel, vertical ribbon, liquid-applied WRB coating, 0.15-mm (6-mil) polyethylene vapor barrier, and southeast orientation;
- EIFS with notched trowel, vertical adhesive ribbons, liquid-applied WRB coating, no interior vapor barrier, and northwest orientation; and
- brick, vented, with southeast orientation to represent the measured RH on the face of the exterior sheathing.

Introducing the simulated flaw in EIFS in the southeast and northwest orientations had only a small effect on RH at the sheathing. Conversely, introducing the flaw in the brick-vented system in the southeast orientation had a much larger effect on RH at the sheathing (Figure 2, page 36).

The EIFS walls that used a liquid-applied WRB performed better in the study than exterior claddings with sheet type membranes. In addition, EIFS walls with an exterior air space ventilation (*i.e.* open at the top and bottom) performed better than walls with just venting, or those open solely at the bottom.

According to the ORNL study, the wall system exhibiting the lowest hygrothermal performance was brick, followed by stucco-clad systems (both three-coat and one-coat), and then cementitious fiberboard cladding.

The results also demonstrated liquid-applied WRB coatings performed better than the other membranes studied, including membranes covered with a mechanically fastened drainage mat.

Using polyethylene vapor retarders increased RH by as much as 23 percent on the EIFS wall facing northwest, compared with the EIFS wall panels facing southeast.

The ORNL study states:

> the wall panels with polyethylene vapor retarders were found to have higher wood moisture content and excessive sheathing relative humidity (80 percent and higher). The results from this study clearly

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indicate that the use of a polyethylene vapor retarder in hot, humid climates, is not a good strategy. In such conditions, interior vapor retarders that are highly vapor-permeable are recommended.

These results imply EIFS layers comprised of vertical ribbons of adhesive and a liquid-applied WRB provided the most effective management of bulk water intrusion into the cladding cavity.[4]

The study indicates EIFS not only absorbed less moisture and heat than brick and stucco during the monitored year, but were also able to better control temperature and moisture within the wall system. Further, EIFS were shown to have the ability to maintain an acceptable balance of moisture and temperature control—a measurement indicative of a well-designed, properly operating, energy-efficient building without moisture problems.

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The EIFS walls used on this hotel and casino can withstand 250-km/h (155-mph) hurricane winds.

Photo courtesy BASF Wall Systems

What's next?

A third phase of the ORNL study involves the first climate model to document performance of eight EIFS walls in eight additional climate zones across the country. The proposed research will produce a range of performance characteristics representative of available EIFS assemblies.

Two stages are necessary to complete this work. The first stage requires the validation of up to eight distinct wall systems from the previously monitored assemblies in Charleston. Analysis will be performed using the 'Moisture-Expert' hygrothermal model or any other suitable model (*e.g.* WUFI). On agreement between the field and hygrothermal modeling result, the model will be utilized to create additional simulations to address performance due to both exterior loading and interior climate controls.

The existing results and prospective model testing will reinforce the understanding of EIFS's capability to control temperature and moisture within the wall system—and its ability to do so better than other recognized exterior claddings.

ORNL Phase III is computer modeling of other climates, due by the end of this year. The results are expected to be available in 2010.

Paradoxically, the future of EIFS is found in its past. As the demand for thermally efficient, sustainable building envelope solutions increases, EIFS finds itself where it began—as a strong contender for architects and specifiers seeking engineered design flexibility that incorporates energy efficiency and air and moisture control at a reasonable cost. **CS**

Notes

[1] Approval for inclusion in *IBC* and *IRC* was the result of continued efforts by the EIMA Board of Directors,

An exterior insulation and finish system was used on this hotel property when the metal panels originally specified exceeded the construction budget. The resulting replication using EIFS also offers enhanced energy efficiency.
Photo courtesy Dryvit Systems, Inc.

its executive director, and the Technical Advisory Committee. Efforts began with EIMA's accreditation as an American National Standards Institute (ANSI) organization in 1999.

[2] See Oak Ridge National Laboratory's (ORNL's) "The Hygrothermal Performance of Exterior Wall Systems." Visit www.eima.com and click on 'Building Envelope Research/Testing.'

[3] Unlike barrier EIFS, drainage EIFS includes a weather barrier (*i.e.* moisture/vapor/air barrier), which is usually liquid-applied to the sheathing before EIFS installation. Water-drainage EIFS add a secondary air and weather protective barrier over the sheathing and a means to allow incidental moisture to drain from behind the insulation board to the exterior of the wall. Other than the redundancy and water evacuation capacity of EIFS with drainage, there are no differences in the benefits derived from the two types.

[4] For a more detailed look at study setup and results, see the EIMA/ORNL "Executive Summary: Exterior Wall Cladding Performance Study." Visit www.eima.com/pdfs/EIMA ORNL ExecSum Final.pdf.

[5] For a map, visit resourcecenter.pnl.gov/cocoon/morf/ResourceCenter/graphic/973.

ADDITIONAL **INFORMATION**

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Abstract

As the demand for thermally efficient, sustainable building envelope solutions grows, the design/construction industry's focus can turn to exterior claddings and the quality of installation. This article compares the hygrothermal performance of different wall systems when considering the entire building envelope, and discusses the consequence of excess water vapor within a wall assembly. It also looks at performance when a 'flaw' is introduced, concluding that exterior insulation and finish systems (EIFS) can offer better moisture control than brick and stucco in the hot, humid climates of Zone 3.

MasterFormat No.

07 24 00–Exterior Insulation and Finish Systems

UniFormat No.

B2010–Exterior Wall Exterior Skin

Key Words

Division 07
Building envelope
EIFS
Moisture control
Oak Ridge National Laboratory
Temperature
Zone 3 climates