Insulated Masonry

Plastics & Bricks Working Together for Energy Efficiency

by Jeffrey A. Nickerson

Masonry construction has long been recognized for its durability, along with its structural, acoustical and fire-resistant benefits. However, it is now also increasingly being seen as an excellent means to stave off increasing energy costs. Providing thermal mass, masonry walls quickly absorb excess solar heat and stabilize indoor temperatures.[1] These attributes are now being enhanced in a composite material that partners masonry with plastic foam insulation to help achieve increased thermal capacity and further inhibit heat flow.

Whether used in the structural load-bearing function of yesteryear or in a newer non-load-bearing wall, masonry has evolved into a highly engineered building component. Its versatility allows expanded polystyrene (EPS) and other foam plastic insulations to complement the energy profile for wall assemblies either as board insulation, custom-molded core inserts, or an aggregate for lightweight concrete.

Advancements in both concrete masonry and rigid foam insulation, along with improved construction methods, offer numerous options when designing for either residential or commercial building projects, including:

- interior and exterior insulated block;
- cavity-insulated block;
- pre-insulated block; and
- mortarless insulated block.

ASHRAE Energy Standards

American Society of Heating, Refrigerating, and Air-conditioning Engineers (ASHRAE) 90.1, *Energy Standard for Buildings Except Low-rise Residential Buildings*, serves as the basis for energy code requirements at the federal level and within most states. As such, it is the most commonly referenced standard for establishing minimum energy efficiency parameters in the design and maintenance of indoor environments. Recognized within the *International Energy Conservation Code (IECC)* and National Fire Protection Association (NFPA) 5000, *Building and Construction Safety Code*, ASHRAE 90.1 has also been acknowledged as the benchmark reference for commercial buildings looking to qualify for tax deductions under the new *Energy Policy Act of 2005 (EPAct 2005)*.[2]

ASHRAE 90.1 addresses the building envelope's vital role in optimizing energy efficiency, covering both prescriptive and performance-based criteria.[3] Section 5 outlines space conditioning categories, compliance paths, and detailed product information and installment requirements for the building elements of wall, roof and floor assemblies. Citing eight climate zones, minimum insulation R-values are stipulated for the various construction methods with the reciprocal U-factors for the assembly maximum. Additionally, Normative Appendix B provides information to determine both U.S. and international climate zones.

In the prescriptive method, most energy codes make adjustments for walls with thermal mass, such as concrete and masonry, recognizing R-values are not a true indicator of energy performance. In most climates, buildings with insulated mass walls save energy compared to those that have the same R-value but lack mass.

Since the mass reduces peaks in the mechanical system loads, first costs for HVAC equipment may also be reduced in some climates. In Tulsa, Oklahoma, ASHRAE 90.1 requires an R-13 + R 3.8 continuous insulation frame wall or an R 11.4 continuous insulation mass wall in some buildings. These requirements are based on the fact that a mass wall is as energy-efficient on an annual basis as a frame wall for this particular climate. (Thermal storage benefits in mass wall construction are influenced by frequent temperature variations, solar radiation, wind and the building's design, operation and maintenance.)

First published in 1975, ASHRAE 90.1 has undergone numerous revisions—the latest changes are geared to simplify—thereby broadening its use. Tied to the sustainable design movement and increasing utility costs, many of the current revisions are intended to facilitate improved energy conservation. This includes a new appendix to rate the energy efficiency of buildings exceeding the standard's minimum requirements and to provide guidance on how to design for certification programs, such as the U.S. Green Building Council's (USGBC's) Leadership in Energy and Environmental Design® (LEED®).

Types of Insulated Masonry

The energy-saving abilities of an insulated masonry wall assembly are significant. Its compatibility with other construction methods allows numerous design configurations that can meet the environmental demands of extreme and moderate climates.

Depending on the materials and type of wall assembly selected, performance criteria can be specified to an exact degree. Designing for energy performance that exceeds minimum requirements is most easily achieved by adding foam plastic insulation.

As a basis of comparison, when using a 13-mm (0.5-in.) gypsum board on a single-wythe wall comprising 203-mm (8-in.) concrete masonry units (CMUs) without insulation, it has an R-3.4. When adding 51-mm (2–in.) of EPS, the R-value increases to 10. However, this does not account for other key factors in determining the assembly's overall energy performance (*e.g.* air tightness, thermal lag, and thermal dampening), making R-value a part of a larger equation.

Measurement systems to determine the thermal performance of independent building materials are based on steady-state coefficients (*e.g.* R-value; C-factor; U-factor), but are not geared to evaluate system performance. As such, they cannot deliver an accurate representation of the achievable interdependent energy savings.

For example, when accounting for the benefits of thermal mass, added insulation, and a 51-mm (2-in.) air space in a cavity wall, the theoretical R-value is 22 versus an R-14.5 when using steady-state data points. This emphasizes the benefit of newer computer software that can project overall thermal performance and further produce measurement gauges to evaluate their accuracy over time.

Interior insulated masonry is a good choice for those familiar with the more traditional block construction. Lightweight metal brackets and rigid foam insulation replace more costly traditional materials while allowing ample space for plumbing and electrical wiring and improved moisture protection. Lightweight aggregates can reduce the weight of the concrete block by up to 25 percent, when compared to traditional units. They also effectively reduce installation time by substantially increasing the number of units per hour a mason can lay.

In an exterior insulated system, the insulation is mounted onto the outside of the block wall and then finished with a simulated stucco or stone facing. These siding systems effectively stop moisture penetration since the insulation and finish are uninterrupted. Wiring or plumbing can be run through the block cavities or traditional furring for drywall can be used on the inside surface. With EPS insulation, increasing the thickness and/or density of the foam board can help improve the structure's energy performance. This method is ideal in climates experiencing temperature swings—the concrete mass on the inside is optimal for storing heat or coolness.

There are several methods available for in-block insulation, which is most commonly used to insulate single-wythe construction.

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hygrothermic conditions can be problematic for certain wall assemblies. The mixed humid climate is defined as having:

- More than 20 inches of annual precipitation;
- Between 3,600 and 5,400 annual heating degree days (base 65˚ F);
- An average monthly winter temperature below 45˚ F.

Testing was done in accordance with ASTM E96-05, *Standard Test Methods for Water Vapor Transmissions of Materials*. Results proved that the wall assembly with EPS insulated vinyl siding had the lowest all-around sheathing moisture value of all nine cladding systems tested.

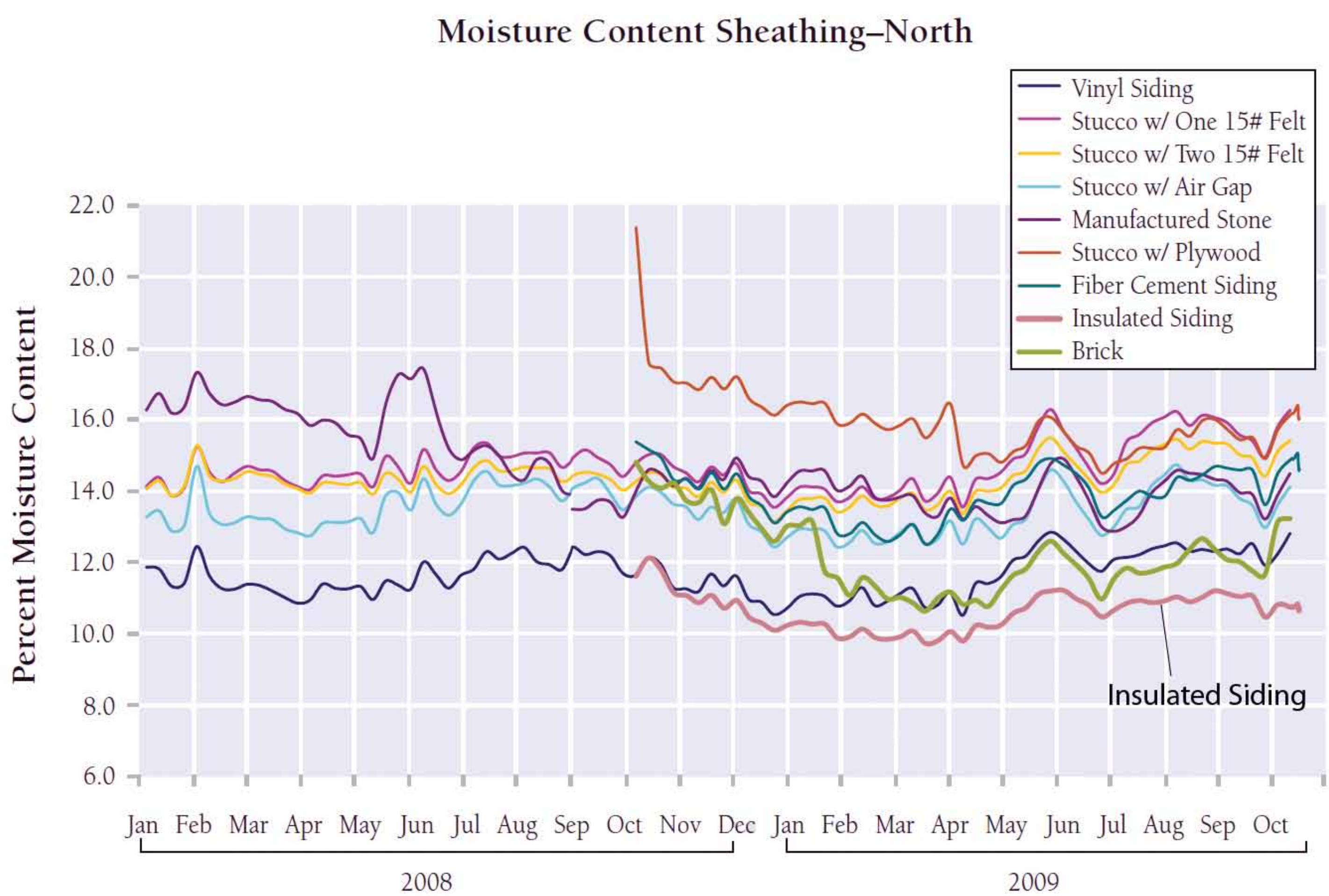
To test the various wall sections, the Research Center performed controlled injections of water behind the cladding at set intervals throughout the duration of the research. Some walls were less able to drain or otherwise dissipate the injected water than others, but all performed satisfactorily in terms of the standard industry moisture content levels.

Under normal weather exposure, the studs and sheathing in all walls tested remained well below 20 percent moisture content, which is the long-accepted industry threshold for wood decay. EPS insulated vinyl siding, traditional vinyl siding and brick were the three driest claddings tested.

During winter months, the warmest wall in the north-facing orientation was the wall clad with EPS insulated vinyl siding. The wall pair with EPS insulated vinyl siding had the lowest all-around sheathing moisture content values. This is attributed to warmer within-wall temperatures during the heating season, which are afforded by the exterior insulation provided by the EPS backing. The warmer temperatures result in lower

within-wall relative humidity values, corresponding lower equilibrium moisture content and increased drying capacity. This field study by the NAHB Research Center proves that vinyl siding with EPS insulation is proven to add energy efficiency to the home while effectively managing moisture and maintaining the driest wall system of all claddings tested.

Craig Drumheller, Senior Energy Engineer with the NAHB Research Center, concludes the following:



- "Insulated siding provides both thermal and hygrothermal benefits in light framed wall construction. The thermal resistance of insulated siding provides a double benefit: reduced heat flow in the wall assembly, thereby saving energy, and a higher wall cavity temperature, resulting in increased drying capacity."
- The full test report states that "moisture issues such as mold and rot, especially in exterior walls, have become a growing concern in residential construction, particularly as building envelopes have become tighter and have incorporated higher levels of thermal insulation as a result of more stringent energy codes and a growing demand for comfortable and energy-efficient homes."

For more information on EPS insulated vinyl siding see EPSMA's online member directory.

EPS Manufacturing

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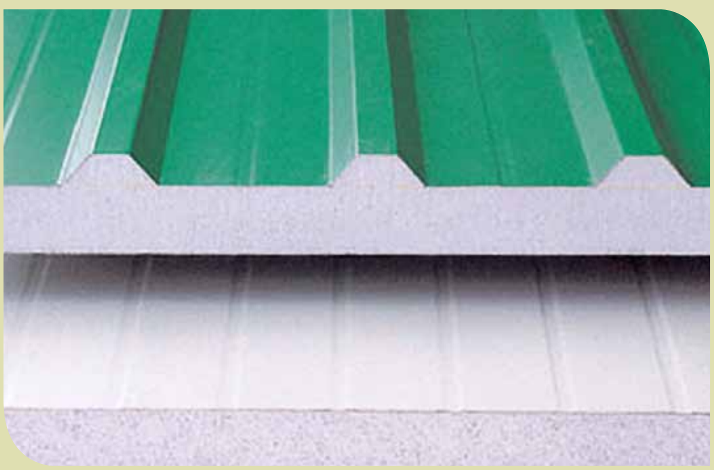

The EPS industry has always been on the cutting edge of manufacturing efficiency. Styro-Tek, a custom laminator of expanded polystyrene insulated panels, recently streamlined their manufacturing process when they relocated their lamination plant to their corporate headquarters in Birmingham, Alabama. The company simplified operations and consolidated its production processes under one roof. The move enabled Styro-Tek to design a new plant layout for its innovative manufacturing equipment, which improved their production flow, eliminated wasted space and increased operation efficiencies. Incorporating state-of-the-art computerized cutting equipment ensures product accuracy. The result? Less errors and product waste.

Versatility, cost effectiveness and lasting value make EPS ideal for a variety of wall and roof constructions. With its outstanding resistance to moisture absorption, EPS insulation provides dependable, long-term performance for interior and exterior construction applications. In addition to aesthetics, laminated EPS panels contribute to a structure's insulation and sound deadening properties. Bonded under pressure, laminated EPS panels can withstand a wide range of environmental conditions. Panels are available laminated on one side or both sides and can be custom cut to any design specification.

There's virtually no limit to laminated EPS applications, including insulated wall and roof panels, signage, service station canopy panels and architectural EPS shapes for schools, hospitals, airports, churches, residential homes and businesses. Exterior coverings for structural insulated panels (SIPS) are available in both stucco embossed aluminum, smooth textured aluminum and smooth textured fiberglass skins. Fiberglass reinforced panels (FRP) are commonly used walk-in coolers, clean rooms and public restrooms. Rigid, scrubbable and fire resistant, FRP's are easy to maintain. Styro-Tek uses an EnergyStar qualified textured polyester paint on its panels that is available in a variety of colors.

By investing in technology and lean manufacturing, the EPS industry is exceeding environmental expectations through reduced waste and increased efficiency.