FACILITIES MANAGEMENT IN THE NEW ECONOMY

INSULATION AND AIR SEALING

COST-EFFECTIVE CARBON NEUTRALITY

nov-dec 2013 / retrofitmagazine.com

retrofit

Health & Happiness:

People Gather and Heal in Unexpected Natural Places

+ More Outdoor Projects

TREND ALERT: break rooms

IMPROVING YESTERDAY FOR TODAY

BEST BUILDING ENVELOPES

A One-time Capital Investment to Improve Your Building's Thermal Performance Is Environmentally and Fiscally Responsible

WRITTEN BY | **STEVE EASLEY**

This cladding system requires a myriad of structural components for support that left little room for insulation.

IMAGES: **STEVE EASLEY** unless otherwise noted

Historically, building professionals mostly have been interested in their buildings' aesthetics, cost, structural performance and maintenance-free claddings. Energy efficiency has been on the back burner, largely because energy has been cheap and codes through the 1970s and early '80s were primarily focused on life-safety issues. This way of thinking has led to some beautiful buildings with "unintended consequences". I'm sure you've heard of the "Death Ray Hotel" in Las Vegas, which had reports of guests being burned poolside by the reflected heat from the sun off the glass curtainwall. Similarly, the "Fryscraper" in London recently melted a Jaguar and started a fire in a barbershop. The glass on these buildings looks beautiful but obviously is not the best configuration for dealing with the sun's radiant energy.

It's very common in the industry for designers to overlook the whole picture. The goal should not only be to design structures that are functional and inspiring to look at, but also energy-efficient, durable, healthy, safe and comfortable. None of these attributes are mutually exclusive. While green-building programs, like LEED, give points for energy efficiency, they don't offer much guidance about how to design and build enclosures that perform in the real world as well as they look on paper. This is because the design and construction industry typically works in a hand-off-type environment, instead of following an integrated design process in which all team members contribute from the start.

Fortunately, there are ways to improve an existing building's performance. The majority of energy costs in commercial buildings are heating, ventilating and air conditioning, and lighting. However, if you are considering a major renovation of your building—recladding or gutting the interior—a capital investment to improve the envelope with insulation and air sealing should be your No. 1 priority.

(continues on page 40)

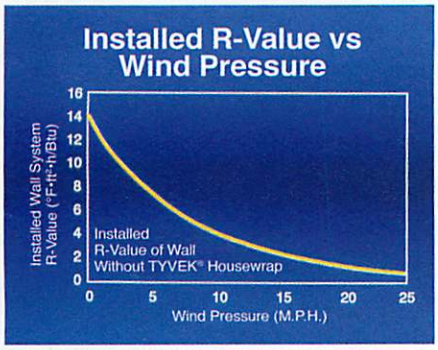

FIGURE 1: Wind washing can have a dramatic effect on insulation performance, illustrating the need for a continuous air barrier.

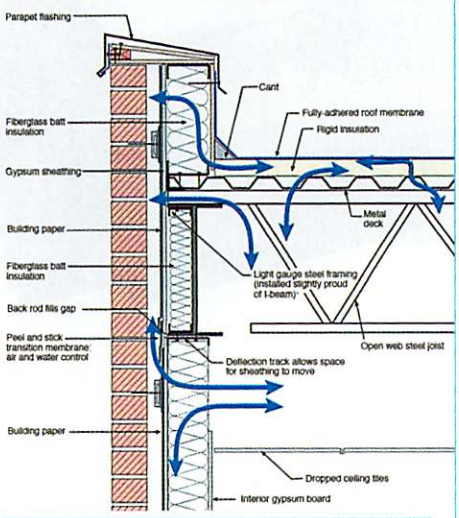

FIGURE 2: This is a typical wall-roof assembly. There is air leakage into and out of everything and everywhere. There is no membrane under the parapet flashing, no air control in the roof or wall assembly and no vapor-control layer. **Building Science Corporation**

Common installation defects with batt insulation.

Managing heat flow, airflow and moisture flow is a multi-part process that requires having a moisture-control layer, thermal-control layer, an air-control layer and a vapor-control layer.

Keys to a High-performance Enclosure

Commercial buildings are much more complex than residential structures in their construction systems, the materials used and the way they are operated. They are often under large pressure differentials, which cause the movement of mass quantities of conditioned and non-conditioned air. This air also contains moisture, which may condense when it comes in contact with cold building materials. Trapped moisture in building cavities or water condensing on non-thermally broken window frames can cause durability problems. When retrofitting your building envelope, the best practice is to select the best materials and methods that work in concert to control heat, air and moisture flow in and out of building enclosures.

Every enclosure should have four layers. Managing heat flow, airflow and moisture flow is a multi-part process that requires having a moisture-control layer, thermal-control layer, an air-control layer and a vapor-control layer. Some materials can accomplish one or more layer functions. Consider the following:

1.] Reducing heat flow by conduction (the internal energy flow from an area of higher temperature to one of lower temperature) requires more than insulation with a good R-value. How insulation is installed is just as important as how much insulation is installed. U.S. Department of Energy, Washington, D.C., studies have shown poorly installed insulation performs at a level 28 percent less than expected. Insulation should be in contact on all six sides with the building components around it and installed without compressions, voids or gaps.

Additionally, thermal bridging—heat flow through the building's framing—can easily cut the effectiveness of the insulation in half. It's not uncommon for buildings to have a 25 percent framing factor. This means for every 1,000 square feet of opaque walls, there is 250 square feet of framing and 750 square feet of insulated cavity. Newer codes recommend continuous insulation (CI) on the building's exterior to reduce thermal bridging.

The percent of windows to wall area also has significant impact on a building's energy use. Use low U-factor fenestration and window frames. (U-factor indicates the rate of heat loss of a window assembly. The lower the U-factor, the greater a window's resistance to heat flow and the better its insulating properties.)

It's also important when selecting windows to consider heat gain from the sun. Select windows with a low solar heat gain coefficient, or SHGC, to reduce air-conditioning costs. High-performance low-E windows can reduce heat loss and heat gain while providing much better visible light transmission than tinted glass.

2.] To reduce heat flow by convection, or air movement in and out of the enclosure caused by air leakage, an effective air barrier system and air sealing must be applied. Convection losses through the insulation are substantial. Insulation works by its ability to trap air, but it often performs differently in the real world than in the manufacturer's testing. Insulation R-values are evaluated under "guarded" hot-box conditions in which there is no air flowing through the insulation. In reality, pressure differentials in buildings cause air to flow through the insulation, significantly reducing its effective R-value. This phenomenon is called wind washing and can be greatly reduced with an air barrier and air sealing. Figure 1, top left, shows the impact of wind washing on R value.

Spray foam insulation can solve many of these problems. In fact, the use of spray-foam insulation in construction has tripled during the last five years. Closed-cell spray foam has air barrier properties, high R-value and absorbs negligible amounts of moisture.

(continues on page 42)

Impact of Thermal Bridging
on Effective Installed R-Value for Steel-Framed Walls

	Actual Cavity Depth, inch	Rated R-Value	Effective R-Value
16 inches o.c.	3.5 in. depth	R-11	R-5.5
		R-13	R-6.0
		R-15	R-6.4
	6.0 in. depth	R-19	R-7.1
		R-21	R-7.4
24 inches o.c.	3.5 in. depth	R-11	R-6.6
		R-13	R-7.2
		R-15	R-7.8
	6.0 in. depth	R-19	R-8.6
		R-21	R-9.0

Source: ASHRAE 90.1-2007

FIGURE 3: ASHRAE values for steel-framed walls show the actual R-value for the wall is less than half the cavity R-value.

3.] To reduce heat transfer by radiation (in which electromagnetic waves transfer heat to an object), cool roof technologies, radiant barriers and low SHGC glass are vital.

4.] Commissioning the building, HVAC and related systems is critical to realizing modeled performance. Many a building has been built in which the systems were never made to operate as they were engineered.

5.] Building enclosure inspection and testing involves evaluating materials and workmanship as the job progresses—not waiting until the building is finished to discover problems when repairs are far more expensive and time-consuming. Also, if you don't measure, you cannot know whether the system is performing as intended. Blower-door technology now is available that can measure the air leakage in commercial buildings.

Continuous Insulation and Air Barriers

Traditionally, we have put insulation between studs; now we're learning that if you move some or all the insulation outboard the framing you achieve better performance because the insulation is more monolithic and greatly reduces thermal bridging. CI is applied to the exterior of a building and is intended to cover all exterior wall assemblies. Many energy codes, like the IECC and ASHRAE 90.1, require CI for steel-framed walls for nonresidential construction in Climate Zone 3 and above.

CI provides a number of advantages. It not only reduces thermal bridging at wall studs, but also reduces thermal bridging through all exterior framing members with the exception of the fasteners. Another CI advantage is it creates a uniform surface for more effective air-barrier application and water-management interfaces. CI also increases wall-cavity temperatures, which helps mitigate in-wall condensation when

(continues on page 44)

Roofing Insulation Advancements >>

In commercial buildings, one of the major sources of envelope energy loss is through the roof, especially in large warehouse-type buildings, like big-box retail stores. Advancements in roofing have led to many new retrofit applications that will increase roof performance and energy efficiency. For example, a spray foam roofing system has been selected to reroof more than 500,000 square feet of terminal and maintenance buildings at Cleveland-Hopkins International and Burke Lakefront airports in Cleveland. The roof system also recently received a severe hail rating from FM Approvals, the testing and certification arm of Park Ridge, Ill.-based FM Global, which is one of the world's largest property insurers.

"The new spray foam roof was more cost-effective because we could apply it directly over our old roof, and it has helped us minimize disruption to passengers," says Rob Henderson, building maintenance manager, Cleveland Airport System. "As a bonus, our insurance premiums are now lower because our insurer, FM Global, approved the roof components."

In addition, the closed-cell spray foam insulation features a next-generation blowing agent with a global warming potential of 1, significantly lower than previous-generation hydrofluorocarbon blowing agents. The blowing agent is nonflammable, has received Washington, D.C.-based U.S. Environmental Protection Agency approval under the Significant New Alternatives Policy Program and is not a volatile organic compound.

"From a contractor's standpoint, there is little to no difference from the blowing agent we have used for years," says Jack Moore, project engineer, West Roofing Systems, La Grange, Ohio. "This was virtually a drop-in; it didn't require any special equipment or additional education for its application."

Moore also notes the product is developing higher compressive strength for a more durable roof surface. He adds: "We are also seeing a slightly greater yield out of the product—somewhere in the neighborhood of 8 to 10 percent, which isn't a lot but when you're spraying a lot of the product, 8 to 10 percent does add up. We're getting an environmental benefit, a performance benefit and we're also getting more material out of the same volume as we were before the switchover to the new blowing agent."

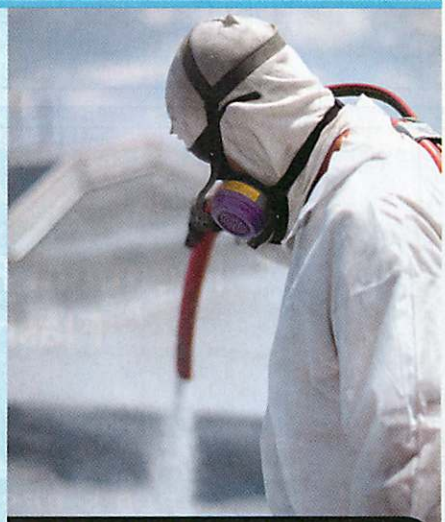

PHOTO: HONEYWELL INTERNATIONAL INC.

Retrofit Materials >>

SPRAY POLYURETHANE FOAM ROOF SYSTEM // West Development Group LLC, wdgsilicones.com

BLOWING AGENT // Solstice LBA from Honeywell International Inc., www.honeywell-solsticelba.com

This 75-year-old-plus apartment building is a retrofitted exterior continuous insulated building. The exterior brick veneer was insulated with closed-cell spray foam, planed smooth with a rotary planer and covered with stucco.

moisture-laden air comes in contact with colder building components.

CI materials commonly used are:

- Extruded polystyrene
- Closed-cell spray foam
- Expanded polystyrene
- Polyisocyanurate

Rigid fibrous insulation

A continuous air barrier is more than just a building wrap. It employs multiple strategies and products to control airflow throughout the entire enclosure, which is key to the performance of insulation. According to a 2005 Gaithersburg, Md.-based National Institute of Science and Technology study, energy savings can be realized by undertaking specific airtightness measures. The study, "NIST report 7238", concluded that air infiltration in commercial buildings could be reduced by 80 percent by employing air barriers, resulting in 25 to 40 percent energy savings.

ASHRAE 90.1 2010 requires commercial buildings have continuous air barriers and the materials that make up the air barrier system be tested to ASTM standards.

The Walpole, Mass.-based Air Barrier Association of America sets strict requirements and functions for air barriers.

Common air barriers are:

- Sheet goods or wraps
- Fluid-applied products
- Board stock taped and sealed
- Spray foam

Our Responsibility

The amount of energy buildings use accounts for probably 36 percent of all our nation's energy use and 25 to 30 percent of all our greenhouse gases; a big component of that is heating and cooling. For example, U.S. K-12 schools spend more on energy than they do on textbooks and computers—$7.5 billion annually. Seventy percent of school energy costs are space conditioning and lighting.

Energy-efficient building is more than just specifying energy-efficient products. Delivered efficiency starts with an integrated design process that considers all building-science principles to ensure real-world performance. Not only is improving your building's energy performance the environmentally responsible thing to do, but as energy costs continuing increasing it's the fiscally responsible thing to do.