NEXT STAGE: SUSTAINABLE DESIGN

Exploring the performance and material considerations of green buildings.

Sponsored by: Guardian Glass, ASI Group, SlenderWall, Roseburg Forest Products, Mermet USA | By: Jeanette Fitzgerald Pitts

COURSE DESCRIPTION
A growing knowledge of how construction impacts the environment and advancements in products’ performance and materials efficiency.

LEARNING OBJECTIVES
After reading this article, you should be able to:

1. Describe how low-e glazing with silver layers helps designers meet code-required thermal performance metrics in both hot and cold climates.

2. Explain how increasing the use of wood in the construction of commercial, industrial, health care and government buildings would significantly reduce the climate change impact of building construction.

3. Compare and contrast the material composition and production processes of types of yarn used to create solar shade fabrics and ways their performance at window and contribution to green building systems differ.

4. Differentiate between architectural cladding products that determine thermal performance through prescriptive and as tested methodologies and select solutions that meet or exceed the code-required level of insulation.

5. Specify the best material for bathroom partitions and washroom accessories that satisfies specific green building design requirements.

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Buildings consume energy in three different ways: energy is consumed to create the various products and materials that make up the building; energy is consumed during the physical construction of the building; and energy is required to operate the building. When the sustainability movement began in the 1970s, it was focused primarily on reducing the amount of energy necessary to keep a building operational. To that end, energy codes and green building rating systems were developed to help designers create buildings that operated more efficiently. Now, sustainable design is entering a new era, where the industry is demanding not only that the buildings be designed to be more efficient, but that proof is gathered to verify that the buildings are actually working more efficiently. There is also an increasing level of interest in reducing the amount of energy consumed by the materials and products selected for a project.

This article explores the performance and materials efficiency considerations as they relate to low-e glazing, architectural cladding, wood products, solar shading fabric, and the materials selected for bathroom partitions and washroom accessories.

DESIGN GOAL 1
ALLOW DAYLIGHT, MANAGE SOLAR HEAT GAIN

Connecting people to the outdoors by providing views and allowing daylight to penetrate a space has become a key tenet of sustainable design, especially as a growing body of research reveals the benefit of these exposures to the health, wellbeing and productivity of building occupants. However, there is a caveat. The inclusion of daylight and views must be done without undercutting the efficiency of the building or subjecting people in the interior to the discomfort that can be caused by glare and solar heat gain. This requires designers to do more than simply fill a façade with glass, they must equip that façade to manage the light and heat present at the window.

Solar energy is dynamic and diverse. It contains visible light and infrared and ultraviolet radiation. The visible light portion of the sun’s energy can range in intensity from 10,000 footcandles (fc) on a bright sunny day, to a few hundred when overcast. Although infrared and ultraviolet radiation may pass into a building unseen, they can have a profound effect on the efficiency of the HVAC system and the comfort of the people inside. When infrared radiation is absorbed by carpets or furnishings, it transforms into radiant heat, which raises the temperature of the interior.

When solar energy reaches a building façade, the façade can reflect it, absorb it or transmit it into the interior. Low-emissivity glass, often referred to as “low-e” glass, is designed to manage the amount of visible, infrared and ultraviolet light that passes through the glass and into a building, with the goal of allowing as much visible light as possible to pass through, while blocking high levels of the heat-creating infrared energy.

Advancements in low-e coatings have improved the effectiveness with which the glazing is able to distinguish visible light from infrared and UV radiation, better protecting the interior from solar heat gain, while allowing it to be filled with daylight. Beyond better performance, a wider range of clarity, color and reflectivity options enable designers to achieve the...
The coatings applied to low-e glass feature several thin metal layers. Although each layer is less than 1/1000th of a human hair, they deliver sophisticated performance enhancements that allow the glass to transmit more visible light into a building, while reflecting a higher percentage of the infrared and UV radiation. The layers can also impact the color, clarity and durability of the glass unit.

Of the various types of metals and oxides combined in a low-e coating, silver has a dramatic impact on the insulating performance of the glazing. There are low-e solutions referred to as single-silver, double-silver and triple-silver low-e glazing, with triple-silver glazing containing the most layers of silver within the coating and delivering the most energy-efficient thermal performance.

Thermal performance refers to the amount of heat that is gained or lost through an insulated glass unit (IGU). There are several metrics used to quantify and compare the thermal performance of a glass solution. The solar heat gain coefficient (SHGC) refers to the amount of the sun's energy that passes through the IGU and into the interior. An IGU with a SHGC of 0.27 will allow 27% of the solar energy to pass into a building, successfully blocking up to 73%. Lower SHGC values indicate that the glazing does a better job of preventing heat from being gained by exposure to solar radiation. There are triple-silver low-e coatings on clear float glass that can offer SHGCs as low as 0.23. Before the triple-silver innovation, designers were often required to specify glass with heavy reflective properties or a dramatic tint to get SHGC values that low.

The U-factor is another metric that describes how well a window assembly insulates the interior by measuring heat gain or loss due to the difference in temperatures on either side of the IGU. Lower U-values indicate that less heat travels through the glass, making the window a better insulator. When creating a project to include more daylight in the interior, while reducing solar heat gain, it is important to explore the amount of visible light that will pass through the glass. This aspect of performance is referred to as visible light transmittance (VLT). A clear-over-clear IGU without a low-e coating can achieve 85% VLT, meaning that 85% of the available visible light passes through the glass and 15% is reflected or absorbed. The high-end VLT that is available from a low-e product is roughly 75%.

Another key metric is the Light-to-Solar-Gain (LSG) ratio, which compares the amount of visible light transmitted through the glass with the solar heat gain coefficient. A 2.1 LSG ratio can be achieved with low-e coatings, meaning that the glass can allow twice as much visible light to pass into a room than heat. Higher LSG ratios indicate that the window is more effectively separating the visible light from the solar radiation and blocking the heat-causing radiation from entering the space.

Glazing with the triple-silver low-e coating can offer very low solar heat gain coefficients, on clear glass, and exceptional LSG ratios, which means that the interior of the building is filling with daylight and not with heat from absorbed solar radiation.

**DESIGN TIP**

**MATCH GLAZING PERFORMANCE METRICS TO PROJECT CLIMATE**

When selecting glazing for a project, designers often start with identifying the level of thermal performance necessary to meet applicable code requirements, either the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 90.1 (ASHRAE 90.1) or an ASTM International Standard, which vary based on the location of the project.

As a general rule, energy codes require that projects in the south be outfitted with glazing that has a SHGC value of 0.25 or lower. This helps minimize the amount of solar radiation that will pass through the glass and into the interior, heating it up and taxing the HVAC system. In northern cities, like Chicago and New York, the codes allow for higher SHGC limits, often above 0.3, because buildings in these climates can benefit from passive heating that occurs when solar radiation enters a space and warms it up during the winter. In fact, the codes for these locations often stipulate the U-value of the glazing, putting an emphasis on minimizing heat loss, instead of preventing heat gain.

Triple-silver low-e coatings can offer designers the daylighting and thermal management solution that keeps solar heat gain low for projects in areas where the sun’s energy is more intense and minimizes heat loss through the IGU for projects in cooler climates.

**DESIGN GOAL 2**

**SPECIFYING A BUILDING ENVELOPE THAT PERFORMS AS DESIGNED**

One of the biggest challenges facing designers as they work to create buildings that are more energy efficient is the reality that there is often a difference between the modeled performance of the building design and the performance of the constructed building. To that end, green building programs are beginning to incorporate elements that require proof of performance once the building is occupied. While these accountability measures are applauded in the sustainable design community, they place another level of responsibility onto the design team that requires the selection of fail-proof or proven products that can withstand the certain degree of chaos and unpredictability that is common on a construction site and then perform as promised once installed.

The building envelope is a great example of an aspect of the constructed environment that can be designed to deliver the requisite level of thermal performance and then actually perform much worse. To understand how this happens, consider a commercial building envelope constructed from traditional architectural precast concrete. In the design phase, the designer probably referenced the thermal requirements for the building as identified in the applicable energy code, either the International Energy Conservation Code (IECC) or ASHRAE Standard 90.1. While there are important nuances to the mandates of each code, there are similarities in how both IECC and ASHRAE approach defining a requisite thermal performance for a building envelope.

Both IECC and ASHRAE Standard 90.1 divide the United States into distinct climate zones, each with its own minimum thermal performance requirements. The code sets specific insulation requirements for the thermal envelope, depending upon the project’s climate zone and the type of walls, whether they are concrete masonry walls, metal, or framed in metal or wood. It also identifies requirements for building thermal envelope opaque assemblies in terms of the acceptable U-factor. The designer specifies a building envelope assembly that is compliant with the applicable code, meeting the prescriptive R-values and U-values, and selects the desired cladding.

During the construction phase, the building envelope, which consists of many disparate parts and pieces, is assembled layer by layer by different teams of workers. The frame is erected. Traditional precast architectural concrete panels, commonly 6 to 8-in.-thick, which will provide the exterior skin of...
the building, are installed. The cavity is filled with insulation. The moisture and air barriers are installed. Mistakes can be made. Gaps occur. Thermal bridging happens. The moisture barrier can be ripped or compromised. These mistakes affect how effectively the building envelope insulates the interior and how efficiently the building operates.

Designers today are looking for building envelope solutions that will perform as specified, reliably creating an efficient barrier against the exterior environment. Factory-built, factory-tested assemblies can eliminate much of the onsite variability that ultimately affects the thermal performance of the occupied building. Solutions like an architectural precast concrete cladding system, which contains the entire envelope system inside a monolithic, panelized unit, can offer designers the reliability they need in this next stage of sustainability, where built performance matters.

SOLUTION
ARCHITECTURAL PRECAST CONCRETE CLADDING SYSTEM

An architectural precast concrete cladding system is a modularized building envelope solution that includes the façade, moisture/air barriers, insulation, and is even available with windows and interior framing. The system features a lightweight 2-in. thick precast concrete panel that is fixed to a light gauge galvanized steel frame with stainless steel fasteners. The way that the exterior concrete face attaches to the frame creates a thermal air gap that is filled with factory-applied, closed-cell foam insulation. The panels weigh one-third the weight of the traditional architectural precast panels, which allows installation to be completed with smaller cranes. This compact and comprehensive building envelope solution also eliminates the need for multiple insulation and interior crews. The cladding system is easily installed upon the building frame and the interior face of the panel is equipped with galvanized steel studs that are ready for drywall, reducing construction schedules.

In terms of thermal performance, these architectural precast concrete cladding systems have been designed to meet current IECC thermal requirements in multiple climate zones. More specifically, this system can be specified in Zones I through 8, which makes it suitable for projects in Miami and the North Slope Borough in Alaska. It is worth noting that manufacturers of building envelope assemblies, like the architectural precast concrete cladding system described in this article, have two code-compliant avenues available for determining the thermal performance of their assembly products. They can use a prescriptive method, which essentially employs calculations to arrive at the expected thermal performance of the solution, or they can test the assembly to attain accurate data on the heat transfer that occurs through the insulated structure in representative test conditions.

“The sustainability movement is moving toward greater degrees of transparency, so that designers have the best, most accurate information available to make their product and system selections,” explained Art Miles, president of Easi-Set Worldwide, a manufacturer of precast concrete. “We believe that designers are going to begin demanding performance data from third-party vendors to ensure the products they select can, in fact, perform as the manufacturers claim they can. We have had our architectural precast cladding system rigorously tested and openly share the tested results.”

The independent laboratory testing, mentioned by Miles, was the American Society for Testing and Materials (ASTM) standard ASTM C1363-11 Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus, during which several architectural precast concrete panels containing varying depths of different closed-cell foam insulations and different sized thermal gaps were subjected to different conditions in a hot box test. The test measures the transfer of heat across the assembly and determines the thermal performance in terms of R-values and U-values of a particular building envelope solution. During these tests, the architectural precast concrete cladding system proved to be an acceptable solution for projects located in climate zones I through 8, meaning it can be used on any U.S. project and in many areas of Canada.

Designers interested in knowing whether the stated R-value or U-value of a thermal performance solution is a calculated estimation, or a proven performance result, should ask manufacturers for more information.

DESIGN GOAL 3
REDUCE EMBODIED ENERGY IN DESIGNS

As sustainable design efforts have succeeded in reducing the energy consumption of buildings by improving the efficiency with which they operate, the community is turning its attention to reducing the energy consumed in the creation of the products and materials that comprise the built structure. The term embodied energy refers to the energy consumed during the construction process and includes the consideration of the energy consumed during the extraction, processing, and manufacturing of each product found within the finished building.

“We understand the dire negative implications associated with greenhouse gas emissions to the atmosphere, and we know that the construction and operation of buildings is a significant contributor to greenhouse gas emissions worldwide,” explains Brendan Owens, senior vice president at USGBC. “Building energy use still represents the largest piece of the greenhouse gas puzzle in buildings, but over the past 40 years the operational efficiency of buildings has improved dramatically. We are even seeing zero-energy building performance goals achieved. As building efficiency improves, the relative importance of the materials we use to construct buildings grows. We’ve introduced credits in LEED designed to help designers minimize another big piece of the total carbon footprint. These credits inform and incentivize the specification of materials that have lower greenhouse gas emissions profiles.”

SOLUTION
SPECIFY WOOD AND WOOD PRODUCTS

Trees, and the wood products derived from them, provide examples of the types of materials that can be used in building design and construction that offer low embodied energy values. In the report, Building with Wood: Proactive Climate Protection, author Dr. Jeff Howe explains, “Trees absorb carbon dioxide (CO2) and water (H2O) and release oxygen (O2). The carbon absorbed is stored until the tree dies and decays or is burned in a wildfire, at which point the carbon is...”
manufactured, carbon emissions (or CO₂ equivalent emissions) are typically less than zero, meaning that more carbon is contained within the wood itself than is released into the atmosphere in the course of its manufacture. “This is a rare and unusual characteristic for a building material to possess. Howe goes on to explain, “The energy required to manufacture wood products is generally about half as much as is contained in them. Consider a glued laminated timber (glam). The process of harvesting and drying the raw material, then manufacturing the glam, consumes less energy than that which has previously been absorbed into the product. And what’s more, trimmings and other scraps generated in converting round logs to timbers are used in making other wood products—particleboard, fiberboard and paper—or is used in generating fossil fuel-free energy. The products themselves, once they reach the end of their life cycle, can be recycled or used to generate energy.”

For proof, look at the Environmental Product Declaration (EPD) for various North American wood products released by the American Wood Council and verified by the Underwriters Laboratories Environment (ULE), an independent certifier of products and their sustainable qualities. An EPD is a document that provides standardized and objective information assessing the lifecycle environmental impact of a product. These EPDs support the claims made in Howe’s report by quantifying the Carbon Sequestered in Product at Manufacturing Gate as a negative (-) value. In other words, the amount of carbon emitted in the creation of a wood product, such as North American Laminated Veneer Lumber (LVL), —up to the point that the product has been manufactured and is ready for shipment, the portion of the life cycle referred to as cradle-to-gate—is negative. More carbon energy is contained within the wood product than has been emitted in the extraction and production of that product.

While the EPDs from the American Wood Council provide a collaborative and industry-wide summary, wood products manufacturers are also investing in generating EPDs that are specific to their product offering and processes. Grady Mulberry, President and CEO of Roseburg Forest Products explains, “We have developed third-party verified EPDs to provide the product-specific environmental information that specifiers and builders are starting to demand. They support the claim that wood products are durable, natural, renewable, and come from sustainably managed forests that capture carbon, making them among the most responsible building materials available today. The EPDs we developed help us demonstrate that wood truly is a superior building material.”

In the U.S., wood is commonly used as the main construction material to build homes. “About 80% of housing units are primarily built of wood, providing millions of tons of carbon benefit, including both the impact that those materials will have inside the built environment, as well as the ultimate end-of-life cycle plan, whether a material will be destined for the dump or repurposed or recycled.

Shading is an important piece of any sustainably-designed project. It is a necessary safeguard that enables a building to provide that critical connection with the outdoors, providing views and access to daylight, while protecting occupants and building performance from the discomfort and energy waste that can occur from glare and solar heat gain. Understanding the basic material compositions of the majority of shading products in the market and comparing and contrasting how those materials perform in terms of view-through, dimensional stability, recyclability, and fire retardancy will help designers select a shading fabric that meets the sustainable demands of a project.

**DESIGN GOAL 4**

**CHOOSE SUSTAINABLE SHADING FABRIC**

A key theme in sustainable design today is that the material matters. It is no longer enough to have a building that performs efficiently and minimizes or eliminates unnecessary energy waste. Designers are being challenged to consider the energy that was used in the production of the materials found in the building and the materials that were used in the building’s construction.

Wood products store carbon for as long as they exist and have low embodied energy values.
There are 100% fiberglass and 100% polyester shade fabrics available. Another popular shading material uses fiberglass or polyester yarn as its core material and coats it with a polyvinyl chloride (PVC). The PVC coating provides the color for the shade and improves the durability, fungal resistance, UV resistance, washability and fire-retardant characteristics demonstrated by the fabric.

VIEW PRESERVATION

View preservation is one of the great advantages of choosing a solar shade over a blind because a solar shade still provides a view to the outdoors when it is pulled into the closed position. A blind product fully obstructs any view to the outdoors when deployed. However, shades constructed from different yarn types provide a different level of view preservation.

Shade fabrics are often specified in terms of an openness factor. While different shade materials can, and do, offer the same openness factors (0%, 3%, 5%), the way the openness is distributed across the face of the material affects the type of view that a person can achieve through the fabric. Fiberglass core yarns tend to be finer than polyester core yarns. When finer fabrics are woven together, the weave has a higher number of holes, or areas of openness, present per square-inch of fabric, than a weave of a thicker polyester core fabric. On average, there are 750 openings in one-square-inch of a fiberglass core material, and only 520 openings in one-square-inch of a polyester core material. The finer fiberglass yarns, which feature a greater number of smaller openings across the material, provide a crisper view through the material. The concept is very similar to the number of pixels on a screen display. The higher number of pixels on a screen, the better its resolution.

OPENNESS FACTOR

The finer fiberglass yarns, which feature a greater number of smaller openings across the material, provide a crisper view through the material.

RECYCLABILITY

The type of yarn used in a fabric also determines the recyclability of the fabric. Solar shading fabrics manufactured from 100% fiberglass or 100% polyester are recyclable. Unfortunately, once the PVC coating is added to a fiberglass or polyester base yarn, the entire shade product is not recyclable.

FIRE RETARDANCY

Fabric flammability is an important performance characteristic to consider when selecting the right materials for a project. Certain types of projects have code-mandated performance criteria that must be satisfied. Regardless of project type, selecting shading materials that will slow down the combustion of the fabric or self-extinguish helps to protect the people and property inside the building when a fire occurs. Shading materials can be classified as either flame retardant or flame resistant. Flame-retardant materials are chemically treated and designed to slow down ignition or combustion. A 100% polyester fabric with a fire-retardant surface treatment is a common example of this type of material. These materials are so common, in fact, that the majority of window shade fabrics available on the market fit into this category.

Flame-resistant fabrics are made from materials that are inherently nonflammable and designed to self-extinguish. Woven from sand and limestone, 100% fiberglass materials are recognized as flame resistant.

In order to determine the performance of fabrics used as curtains, draperies and other window treatments, the National Fire Protection Assn. (NFPA) developed a test method to assess the propagation of flame across various textiles under specified fire conditions. NFPA 701 is a fire-retardancy testing standard required by the International Building Code (IBC) for textiles used in public spaces such as schools, churches, auditoriums, theaters and commercial buildings. The standard is designed to evaluate textiles that will hang freely (e.g., roller shades). The test method exposes 10 individual samples of a specified size to a flame for 45 seconds. The weight loss of the fabric and the presence of a residual flame is measured. In order for a fabric to pass the NFPA 701 test, the total weight loss of the sample cannot exceed 40% and the residual flame cannot last longer than an average of two seconds. Look for solar shades that are compliant with NFPA 701 to specify a material that will help protect life safety in the event of a fire.

It is common practice to specify a shade fabric based on its color and openness factor, but the composition of the material can make a material difference in the way the shade performs.
sustained exposure to moisture and the exterior surface of the material can react to water as well.

Steel products designed for use in a bathroom have often been engineered for rust and corrosion resistance. A powder coating on galvanized steel improves the corrosion resistance of the surface. Quality stainless-steel products (Type 304) incorporate a mix of elements that enhance corrosion resistance. For example, while most stainless-steel alloys contain some amount of iron, which easily oxidizes to form rust, they also contain a high percentage of chromium, which creates a protective layer on the metal surface and resists corrosion of the material.

Powder-coated and stainless-steel bathroom partitions and washroom accessories are also susceptible to vandalism. The paint can be scratched off a powder-coated steel product, which will require the surface to be repainted in order to fix the damage. While stainless steel surfaces can be scratched, they can be buffed to remove the markings. Both types of steel can be dented or dinged with force. In areas that must withstand a rowdier crowd, like opposing team locker rooms in high schools and universities, consider specifying a higher gauge stainless steel for washroom accessories. Some manufacturers offer 16-gauge stainless steel, which is the thickest, most-robust stainless-steel material available in these products.

High-density polyethylene (HDPE) is a solid plastic material that is well suited to deal with the hazards of bathroom dwelling. With HDPE, the color is physically integrated throughout the material, not added on top of it at a later stage as a coating or laminate. As a result, bathroom partitions made from HDPE will never delaminate or need repainting.

The non-porous surface is incredibly strong and impermeable, which enables HDPE bathroom partitions to resist mildew, mold, corrosion, dents, scratches and graffiti. These durable surfaces cannot be dented or dinged easily. Scratches are less noticeable, because the color is homogeneous throughout the partition, and easily repaired. Graffiti wipes off easily with most non-abrasive cleaners.

Plastic laminate toilet partitions have a rigid, decorative outer layer, which is applied to a substrate typically made of particleboard. If moisture seeps through the black seams caused by standard edge banding, this particleboard can expand and warp causing the top sheet to delaminate from the core. One manufacturer, however, offers plastic laminate partitions without the standard black seams, by engineering a unique edge banding system that fuses with the substrate to create a seamless beveled profile. ASTM tests confirm this upgrade has an increased resistance to moisture and humidity, providing more than three times greater durability than standard plastic laminate partitions.

Designers should avoid using standard plastic laminate partitions in an indoor swimming area or natatorium, because the material will not withstand the continued exposure to the moisture and chemicals in the air. In terms of durability, the plastic laminate sheet, which acts as the protective top layer, is tough, but can be damaged. While vandals may find it hard to scratch the surface, they may be able to delaminate the top sheet in standard plastic laminate with enough effort.

Phenolic material is also impervious to water, which makes it an optimal choice for showers, saunas and aquatic facilities, as the material is impenetrable to mildew, mold and odor. Phenolic bathroom partitions are available with a black core or can be created with the surface color integrated throughout the panel, like HDPE. From a coordinated design perspective, both bathroom partitions and washroom accessories have been made in the phenolic material, enabling specifiers to create a cohesive look throughout the space. It should be noted that, when selecting washroom accessories, it is important to pick products that have the appropriate capacity for the application. Phenolic material is comprised of a black core, or can be created with the surface color integrated throughout the panel, like HDPE. From a coordinated design perspective, both bathroom partitions and washroom accessories have been made in the phenolic material, enabling specifiers to create a cohesive look throughout the space.

Solid surface materials, such as marble and granite, can also be used for bathroom partitions and urinal dividers. These materials are impervious to humidity and resistant to damage from water and cleaning chemicals. However, the use of these surfaces can be expensive, as both the materials and installation costs are much higher than the costs associated with buying and installing a powder-coated, stainless steel, HDPE, plastic laminate, or phenolic partition.

Beyond choosing a material that can perform in the bathroom or locker room space, mainstream sustainability considerations now encourage designers to seek materials that also feature a low embodied energy, recycled content, or the quality of being built from rapidly renewable resources and low-VOC emissions that have been verified. HDPE bathroom partitions can be provided with up to 100% post-consumer recycled content and up to 33% post-industrial recycled content. The make-up of products made from phenolic materials is documented as containing an impressive 67% of rapidly renewable materials; phenolic materials that are color-invasive have earned GREENGUARD certifications for achieving low-VOC emissions.

There are additional considerations for bathroom design that should be made, although they currently fall outside the definition of sustainable design. Occupant comfort is a key piece of the sustainable design algorithm. To that end, many schools have opted to incorporate high-privacy bathroom partitions, even though they are currently outside the regulations stipulated in the Americans with Disabilities Act (ADA), or the IBC, or a green building rating system, because they improve the comfort of people using the restroom. A high-privacy restroom partition eliminates sightlines into the occupied stall and makes it more difficult for people to peek under the door or over the walls. This singular feature may not make a bathroom operate more efficiently, but it can have a marked improvement on the comfort of the people using the space.

In summary, the market has reached the next era of sustainable design. Success in the marketplace further reduces the carbon footprint of a project and helps to maintain the momentum of this movement.

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