Oldcastle® Architectural Products, Sustainable Design, and LEED® v4

A report to Oldcastle® on the attributes of Oldcastle Architectural and Hardscapes Products relative to sustainable building design.

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11/24/15

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Introduction: Evaluating Green Building

Green building is firmly established in the commercial new construction market, and demand for green building materials continues to grow. The U.S. Green Building Council (USGBC®) has LEED®-certified over 4 billion square feet of building space throughout the world.[1] Numerous federal government agencies and state governments have enacted green building initiatives. In many cases, these initiatives move beyond voluntary measures to green building code requirements or requirements for LEED-certification of public and in some cases, private, new construction.

The *LEED® Building Design and Construction: New Construction and Major Renovation* green building program (LEED) [Ref. 4], developed by the USGBC, is perhaps the most widely used green building program in the U.S. It is a voluntary program that allows designers to pick and choose which of the various credits they want to pursue. LEED rating systems exist for not only new commercial construction, but also for everything from schools to data centers, as well as for commercial interiors, building operations and maintenance, neighborhood development and homes. While the specifics of each rating system vary, all share an organization that considers the building site, location and transportation, water efficiency, energy and atmosphere, materials and resources, and indoor environmental quality. See Figure 1.

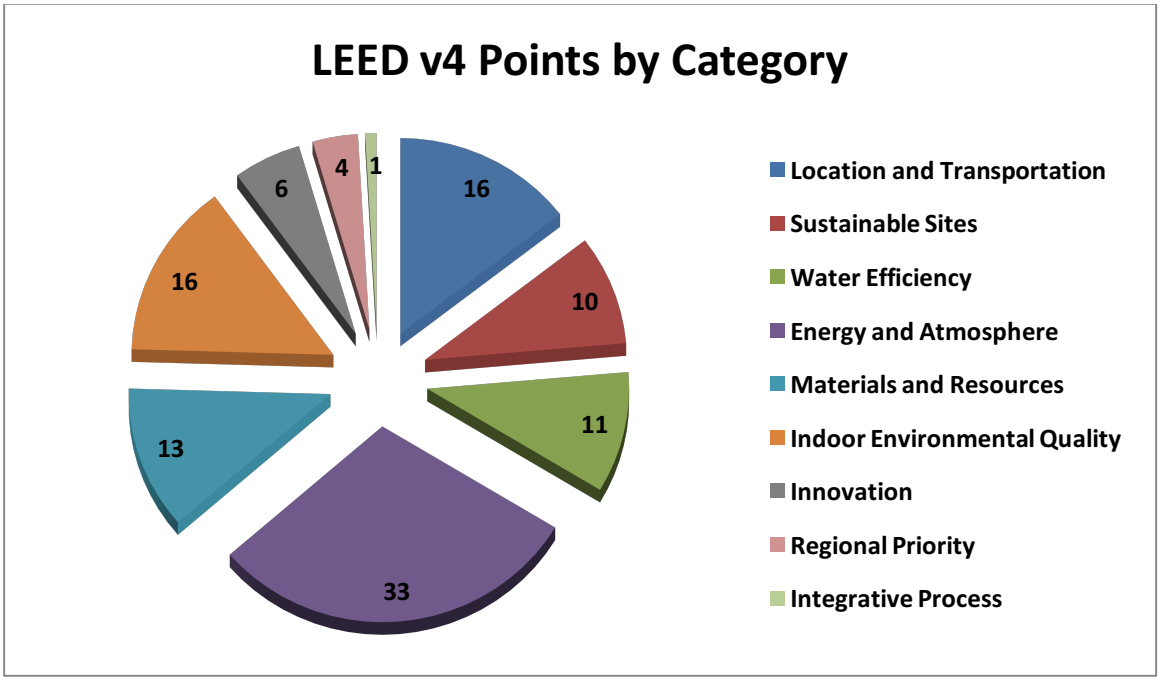

Figure 1: LEED® v4 Building Design and Construction: New Construction Categories

[1] http://www.gbig.org/collections/14544, accessed October 2015.

The *LEED® Canada for New Construction* 2009 rating system [Ref. 3] is based on the U.S. version, LEED 2009. Some of the most notable differences for building products are that LEED® Canada includes a credit for utilizing durable materials (Regional Priority credit Durable Building), recognizes differences in method of transport for building products (Materials and Resources credit Regional Materials), and allows for a specific recycled content calculation for products utilizing cement replacements (supplementary cementing materials) (Materials and Resources Recycled Content). Going forward Canada will not develop a separate rating system but will use LEED v4, and it is expected that these distinctions will likely be lost.

Though LEED may be the best known green building program, it is not the only one. The ASHRAE 189.1 *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings* (ASHRAE 189.1) [Ref. 7] is one alternative to the LEED rating system. ASHRAE 189.1 is similar to LEED with a few key differences, the primary being that ASHRAE 189.1 is written in mandatory, code-enforceable language. ASHRAE 189.1 is intended as a minimum green building standard. Unlike LEED, designers using ASHRAE 189.1 have very few choices regarding the provisions of the standard. Most of the provisions of ASHRAE 189.1 are required. As a result, ASHRAE 189.1 can be adopted by a local jurisdiction either directly or as a compliance path within the *International Green Construction Code* (IgCC™) [Ref. 2].

The IgCC is an overlay green building code written in mandatory language for adoption in conjunction with the *International Building Code*. The 2015 and prior editions of the IgCC were developed by the International Code Council and were loosely based on the LEED rating system. Future editions of the IgCC will have technical content based solely on the ASHRAE 189.1 standard. The IgCC contains mandatory requirements but allows for some jurisdictional choice in selecting the provisions to be part of the code.

In addition to the green building programs mentioned above, there are other less widely used programs. The *Green Building Assessment Protocol for Commercial Buildings©* (ANSI/GBI 01-2010) [Ref. 1] is a consensus standard developed by the Green Building Initiative (GBI) that is used as the basis for the Green Globes online building and management environmental audit. This program allows for either self-assessment or third-party verification of a building's design and construction. The *National Green Building Standard™* (NAHB/ICC 700-2008) [Ref. 5] covers residential construction and was developed by the National Association of Home Builders (NAHB) and the International Code Council. There are also state and local green building codes which are beyond the scope of this white paper.

The SITES v2 Rating System [Ref. 6], owned by Green Business Certification Inc., is a green rating program focused on sustainable land design and development. It is applicable to sites that may or may not include buildings. It is organized much like LEED and contains credits in the areas of pre-design and planning, water, soil and vegetation, material selection, human health and well-being, construction, operations and maintenance, and education and performance monitoring. Most credits in SITES do not impact the building itself. Concrete masonry hardscapes products can contribute toward many credits within SITES, but further discussion of SITES is beyond the scope of this white paper.

Sustainable Design

While each of the green building rating programs is slightly different in content and approach, there is general agreement on the importance of evaluating:

- energy efficiency
- water efficiency
- land use (sites)
- materials and resources (resource efficiency)
- pollution (global impact)
- indoor environmental quality (health and well being)
- transportation
- operations and maintenance

Green building is not however, necessarily the same as sustainable design. Sustainable design refers to the design and construction of buildings in a way that meets the needs of today without compromising the needs of the future. With green building the focus is often limited to environmental impacts, but true sustainable design considers the economic and social aspects of the design in addition to the environmental impacts and looks to balance this "triple bottom line." Sustainable building design is a holistic look at the entire building process. As a result, this report also includes other aspects of sustainable design that may not be included in current green building rating programs such as:

- environmentally preferable products
- durability
- life cycle cost
- safety and security
- acoustic comfort
- visual comfort (aesthetics)
- efficient use of materials
- avoidance of waste

Oldcastle® Architectural Masonry & Hardscapes Products

This report covers Oldcastle® Architectural concrete masonry and hardscapes "national product offering" including lines marketed under the Echelon™ and Belgard® brands – Trenwyth® masonry block, Quik-Brik®, Artisan Masonry Stone Veneers®, Performance Upgrade Options and Systems, Amerimix® bagged goods and Belgard® hardscapes. This report focuses on products used in sustainable commercial building designs. Though many of the sustainable strategies listed in this report may also be appropriate for residential construction, the residential market has several unique aspects that are only covered briefly here. Insights into the suitability of Echelon masonry products and Belgard hardscapes products for sustainable design strategies are based on information provided by Oldcastle Architectural, and information obtained online.

Evaluating the applicability to sustainable design strategies requires an understanding of the use of the product and its manufacture. Based on information received from Oldcastle Architectural and obtained online, the following generalizations can be made.

Primary ingredients in all Echelon masonry and Belgard hardscapes products are cement, sand and other aggregates, and water. Admixtures may also be included to give the units color, resistance to water penetration, or other properties. The raw ingredients are mixed together and then formed by machine. They are typically cured in a chamber at temperatures between 100 °F to 140 °F at high humidity. In some cases recycled materials may be used such as post-consumer glass, slag cement, or recycled aggregate.

Products are manufactured at facilities located throughout the U.S. and Canada. Raw materials are locally sourced where available. Similarly, recycled materials used vary from plant to plant depending upon local availability.

Echelon Masonry, Belgard Hardscapes and Sustainable Design Principles

The applicability of a product to a sustainable building design strategy depends both on its use and on characteristics of its manufacture. This section describes sustainable design principles applicable to Echelon Masonry and Belgard paver products. Information related to specific LEED and other green building program criteria can be found in the sections at the end of this report.

Energy Efficiency

An energy efficient building envelope is a key component in sustainable building design. Achieving an energy efficient building envelope includes consideration of both the insulating value of materials as well as the thermal mass of materials. Thermal mass as found in masonry products helps to reduce indoor temperature swings and often leads to reduction in the size of mechanical heating and cooling systems. The benefits of thermal mass are most accurately reflected when utilizing energy analysis programs that analyze the building over a 24 hour period, 365 days a year.

All Echelon Masonry products provide some measure of thermal mass. Thermal mass is directly proportional to the weight of the material. Thermal mass is most effective when used on the interior side of the insulation in the building envelope. This includes load-bearing concrete masonry as part of a cavity wall system as well as interior concrete masonry walls and interior stone applications. Echelon offers two masonry systems that combine the thermal mass benefits of concrete masonry with integral insulation—InsulTech™ System and EnduraMax™ High Performance Wall System. See Figures 2 and 3. In addition many Trenwyth concrete masonry units offer the option for factory-installed expanded polystyrene insulation in the cells of the units.

Figure 2: InsulTech™ System (R-value of 16.2)

Figure 3: EnduraMax™ High Performance Wall System (R-value of 9.2)

Environmentally Responsive Site Planning

Environmentally responsive site planning includes consideration of site selection, site disturbance, storm water management, and effect of the building on its surroundings. Permeable pavement systems and grid pavers are often used on sustainable building designs to reduce the heat island effect and reduce storm water runoff.

The heat island effect is that effect whereby dark colored surfaces retain excess heat creating a microclimate. This is why nighttime temperatures in the countryside are often much cooler than in the city. The heat island effect can be reduced by shading of horizontal surfaces, by introducing vegetation, or by utilizing light-colored or reflective materials for the hardscape on a project. Belgard commercial pavers, including the Moduline Series™, come in several colors that meet solar reflectance criteria and can be used in applications ranging from parking lots to plazas. Belgard Turfstone is a grid paver that allows vegetation to grow through it.

Permeable pavers are an important strategy in managing storm water. Belgard offers a number of permeable paving options, including the Aqualine Series™, designed to manage storm water. Other Belgard pavers may also allow water to permeate depending on the design of the installation.

Permeable pavers that also meet the requirements for heat island mitigation can be counted toward both strategies.

Environmentally Preferable Materials and Products

Consideration of the environmental impact of building materials and products is an important element in a sustainable design, though it is only one of several criteria to be considered for product selection. Materials should be evaluated over their entire life cycle, from raw material extraction to end of useful life. In this context environmentally preferred products should incorporate one or more of the following strategies:

- Abundance of raw materials
- Efficient use of raw materials
- Use of bio-based or rapidly renewable materials

- Use of recycled materials
- Sustainable measures in acquisition or manufacture
- Use of regionally available materials (near to building project site)
- Regional manufacture or fabrication (near to building project site)
- Recyclable
- Salvageable
- Durable
- Non-toxic (not made of toxic materials)
- Avoidance of construction waste

Echelon Masonry and Belgard hardscapes products may incorporate several of these sustainable strategies. These are discussed in the paragraphs below and the sections that follow.

Abundant and Efficient Use of Raw Materials. Many Echelon masonry and Belgard products use sand which is considered an abundant raw material as an aggregate. Sand is also a primary ingredient in Amerimix mortar, grout and stucco products. Common aggregate which is used in both Echelon masonry and Belgard products is also an abundant raw material. The manufacturing process for these products has little waste. Up to 98% of raw materials are used in the final product.

Recycled Material Content. According to the information provided on the Echelon Masonry website in regards to Trenwyth, the following products contain a significant amount of recycled content:

- Astra-Glaze-SW+® glazed masonry units
- Verastone® recycled ground face masonry units
- Verastone® Plus recycled filled & polished ground face masonry units
- Acousta-Wal® / Astra-Glaze-SW+® sound-absorbing masonry units
- Acousta-Wal® / Verastone® sound-absorbing masonry units

Recycled content materials vary with the location of manufacturer but may include up to 20% – 30% by weight post-consumer recycled glass, slag cement (ground granulated blast furnace slag), and crushed concrete for aggregate.

Belgard hardscape products may also contain recycled content including fly ash and slag cement depending upon manufacturing facility.

Regional Manufacturing. Oldcastle operates manufacturing facilities nationwide, including more than 150 facilities. Most aggregate is sourced close to the manufacturing plant. Most plants source approximately 80% (by weight) of their raw materials from within 500 miles of the factory, some within 100 miles, although in most rating systems it is the distance between material extraction, as well as manufacturer, and the project site that is calculated.

Sustainable Practices in Manufacturing. Oldcastle strives for efficiency in manufacturing. Recent efforts include installation of energy efficient lighting in plants company-wide, reuse and recycling of wood pallets, and use of packaging with recycled content.

Recyclable. The masonry components of all Echelon masonry and Belgard hardscapes products are recyclable. Ground concrete masonry units can be used for structural fill or as aggregate in new block.

Salvageable. Belgard pavers are easily salvaged and reused. Their mortar-less installation allows for ease of replacement and reuse.

Life Cycle Assessment and Product Declarations. There are several aspects to consider in the environmental evaluation of building materials. Life cycle assessment (LCA) allows for a complete examination of all aspects of building material manufacture and use. It includes all impacts from raw material acquisition to manufacturing to building maintenance and end of building life. This is often called "cradle to grave" for building materials. At a minimum, LCA must include impacts from raw material acquisition (cradle) to the manufacture of finished product (gate). The results of an LCA can be reported by a manufacturer, or can be used to develop an Environmental Product Declaration (EPD). An EPD is a formal reporting of the life cycle impacts of products and is done according to specific rules.

Oldcastle Architectural is in the process of conducting life cycle assessments on the Trenwyth family of products as well as the InsulTech masonry system with the goal of publishing an EPD for them. A Type III, third-party verified EPD for Belgard pavers produced at the Anchor, An Oldcastle Company, Easton, PA plant is available online at http://info.nsf.org/Certified/Sustain/ProdCert/EPD10050.pdf.

Durability and Life Cycle Cost Analysis

Costs of building materials should be considered over the entire life span of the building. Durable materials like masonry products generally have an advantage in that because of their long life and low maintenance, their life cycle costs are often low as compared with products that have a low initial cost but high life cycle cost.

Safety and Security

Safety and security are important aspects of sustainable design. Fire-resistant construction and resistance to impacts and wind-borne debris promote occupant health and safety. All Oldcastle Echelon masonry and Belgard hardscapes products are non-combustible though some incorporate insulation or other ancillary components that may not be. Masonry is also resistant to impacts. In areas where extra protection is required, grouting and reinforcement can be added to concrete masonry.

Acoustic Comfort

Acoustic comfort is another important element in sustainable designs. Walls with high Sound Transmission Class (STC) values provide superior acoustic insulation. STC values for concrete

masonry units vary depending on the size of the unit, unit density, and any fill in the cells. Typical STC values range from 45 for a lightweight 8 inch unit to over 60 for a fully-grouted 12 inch unit, easily achieving the minimum STC for walls of 45 to 60 required by most rating systems with acoustic criteria. In addition, Echelon Acousta-Wal units provide sound absorption at all frequencies, even low frequencies that can be hard to control.

Superior Indoor Environmental Quality

Superior indoor air quality encompasses both the reduction/elimination of pollutants in a building (i.e. tobacco smoke, chemical pollutants) as well as moisture control to help prohibit mold. Concrete masonry is inert, is not a food source for pests or rodents, does not support mold growth, does not produce volatile organic compounds (VOCs) nor any hazardous chemicals currently designated as having high health risks.

Quik-Brik, Artisan Masonry Stone Veneers, and the masonry units used with the EnduraMax Wall System are typically not coated or sealed and as a result do not contain any VOCs. Likewise, the standard finish on InsulTech is VOC-free.

Trenwyth's factory-applied sealants, Trendcoat® (acrylic based) and Trendcoat® WB (water based), are applied to all polished ground face and filled and polished faces. Both the factory-applied sealant and the field coating sealant emit either low VOC's or no VOC's. This applies to the following Trenwyth products:

- Verastone® recycled ground face masonry units
- Verastone® Plus recycled filled & polished ground face masonry units
- Trendstone® ground face masonry units
- Trendstone Plus® filled & polished ground face masonry units
- Acousta-Wal® / Verastone® recycled sound-absorbing ground face masonry units
- Acousta-Wal® / Trendstone® sound-absorbing ground face masonry units

Efficient Use of Materials

Oldcastle Echelon masonry products provide both structure and finish in one product. This efficient use of materials eliminates resources associated with other finishes as well as the time needed to install other products.

The LEED® v4 Rating System

In fall 2013 U.S. Green Building Council formally launched LEED v4. The suite of LEED rating systems that make up LEED v4 now addresses an even broader array of buildings that make up 21 different market sectors. LEED rating systems are organized into the broad categories of building design and construction (BD+C), interior design and construction (ID+C), building operations and maintenance (O+M), neighborhood development (ND) and homes (HOMES). Within each of these broad categories numerous types of construction are covered. One of the most widely used rating systems is BD+C New Construction. As a result, this white paper focuses on the credits found in that rating system.

The newest version of the Leadership in Energy and Environmental Design®, or LEED, rating system, known as LEED v4 introduced a new approach for building materials and products. LEED v4 introduced three entirely new credits in the Materials & Resources section focused on product disclosure. This white paper examines these new credits and others in LEED v4 and their connection with Oldcastle Architectural Echelon masonry and Belgard hardscape products.

Changes to Materials and Resources in LEED® v4

The most significant changes in LEED v4 occurred in the Materials and Resources category. In LEED 2009 the Materials and Resources (MR) category awarded points in credits focused on the attributes of recycled content, regional materials, rapidly renewable materials, and certified wood, as well as reuse of materials and construction waste management. LEED v4 takes an entirely different approach. The focus of MR in LEED v4 is on product transparency. Six of the 13 possible points relate to product ingredient disclosure, including environmental product declarations (EPD), supply chain reporting and material ingredient reporting. Other significant changes in the MR category include the addition of whole building life cycle assessment and the elimination of regional materials as a stand-alone credit. The credits that form the MR category in LEED v4 are shown in Table 1.

Table 1: LEED v4 Materials and Resources Category

Credit	LEED v4	Points	Description
Prereq	Storage and Collection of Recyclables	Req'd	Requires a place for storage and collection of recyclables.
Prereq	Construction and Demolition Waste Management Planning	Req'd	Requires implementation of a construction waste management plan.
Credit	Building Life-Cycle Impact Reduction	5	Options 1-3 reward reuse of buildings and materials. Option 4 covers whole building life cycle assessment for new construction.
Credit	Building Product Disclosure and Optimization- Environmental Product Declarations	2	Rewards reporting of environmental impacts of building products.
Credit	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2	Rewards reporting of raw material sources and type of raw materials (i.e. recycled content).
Credit	Building Product Disclosure and Optimization - Material Ingredients	2	Rewards material ingredient disclosure via chemical screening tools.
Credit	Construction and Demolition Waste Management	2	Rewards diversion of wastes from landfill in addition to reduction of total construction waste.

LEED® v4 Credits and Oldcastle and Belgard Products

Many Oldcastle Architectural Echelon masonry products and Belgard pavers can contribute toward earning LEED® points on a project in several credit categories as described below.

Sustainable Sites

Credit – Rainwater Management: This credit awards up to 3 points for managing rain water runoff using low-impact development or green infrastructure strategies. Recommended strategies include the use of permeable paving. Belgard Aqualine Series pavers are especially suited to this use. Other Belgard pavers may also allow water to permeate depending on the design of the installation.

Credit – Heat Island Reduction: This credit awards 2 points if the combination of the roof and non-roof surfaces meet the specified criteria for solar reflectance. Strategies for the non-roof areas include use of paving materials with a three-year aged solar reflectance (SR) of at least 0.28 or an initial value of 0.33. Several colors of Belgard pavers meet these requirements. An open grid pavement system that is at least 50% unbound can also be used.

Energy & Atmosphere

Credit – Optimizing Energy Performance: This credit, worth up to 18 points, awards points for reduction in building energy use as compared with baseline requirements based on ASHRAE 90.1-2010. All concrete masonry can contribute toward an energy efficient building shell. The benefits of thermal mass provided by concrete masonry include moderation of indoor temperature swings and delayed heat transfer. The InsulTech System, EnduraMax System and other insulated concrete masonry units provide an added advantage in meeting energy efficiency goals. The InsulTech System utilizes BASF Neopor® EPS molded insulation inserts providing a 16.2 R-value at 75 F, and the EnduraMax System a 9.2 R-value steady state.

Materials & Resources

Credit - Building Product Disclosure and Optimization - Environmental Product Declarations (EPD): One point can be earned if at least 20 different permanently-installed products that have an EPD are used. Oldcastle Architectural is currently developing an EPD for InsulTech and the Trenwyth family of products. An EPD for Belgard pavers manufactured at the Easton, PA facility is available at http://info.nsf.org/Certified/Sustain/ProdCert/EPD10050.pdf.

Credit - Building Product Disclosure and Optimization - Sourcing of Raw Materials: Option 2: Leadership extraction practices awards 1 point if at least 25% by cost of the total value of permanently installed products on the project meet at least one of the responsible extraction criteria. Responsible extraction criteria include the use of recycled content materials and the use of salvaged materials. Astra-Glaze-SW+, Verastone and Verastone® Plus units are among those available with significant recycled content. Oldcastle Architectural manufacturing facilities may also have the ability to add recycled content to other CMUs. Salvaged Belgard pavers that are reused can contribute toward this credit.

Credit - Building Product Disclosure and Optimization - Material Ingredients: Option 1: Material ingredient reporting awards 1 point if at least 20 different permanently-installed products report chemical inventory of the product to at least 0.1% (1000 ppm). Reporting options include using Chemical Abstracts Service Registry Numbers (CASRN), Health Product Declaration, or Cradle to Cradle certification. Oldcastle Architectural plans to publish Health Product Declarations (HPD) for the Trenwyth family of products as well as the InsulTech concrete masonry system.

Credit – Construction Waste Management: Projects can earn up to 2 points in this credit for either diversion of waste or minimization of total construction waste on the project. Most Oldcastle Architectural Echelon masonry and Belgard hardscape products are recyclable. They also help to minimize construction waste on site because the modular nature of masonry minimizes on-site cutting.

Indoor Environmental Quality

Credit: Low-Emitting Materials: This credit, worth up to 3 points, focuses on volatile organic compound (VOC) emissions. This credit requires that 100% of the ceiling and wall materials used meet General Emissions Evaluation criteria to be considered a compliant category. Stone, glass, concrete, and clay brick are listed as "…inherently non-emitting and comply without any testing if they do not include integral organic-based surface coatings, binders, or sealants." Oldcastle Architectural offers many concrete masonry and hardscape products that do not include integral organic-based coatings, binders, or sealants. The Trenwyth family of products do include a factory-applied coating that may or may not meet the California Department of Public Health Standard Method v1.1-2010 requirements.

In addition, for Healthcare and Schools only, also require exterior applied products to comply with the VOC criteria. Oldcastle Architectural products without added coatings used in this application also comply.

EQ Credit: Acoustic Performance: LEED v4 for New Construction now includes a credit for acoustic performance. A credit for acoustic performance was previously only found in the LEED for Schools rating system. This credit includes sound transmission class (STC) requirements for interior walls ranging from 45 to 60 depending on the occupancy of adjacent rooms. An STC of 50 is required between hallways and adjacent rooms. Typical STC values for standard concrete masonry units range from 45 for a lightweight 8 inch unit to over 60 for a fully-grouted 12 inch unit. The EnduraMax wall system has an STC of 61 or more and Quik-Brik has an STC of 45 to 48. Acousta-Wal units also provide sound absorption at all frequencies, even low frequencies that can be hard to control.

Other LEED Credits

The LEED Rating System also includes credits for Innovation and Regional Priority. Innovation credits vary from project to project but typically include strategies not covered in LEED, LEED

Pilot Credits, or going beyond the LEED requirements. Regional priority credits give added weight of up to four points to credits identified by USGBC's regional councils and chapters. In many areas of the country sustainable sites credits related to rain water management and heat island effects are identified as regional priority credits.

Summary of LEED® credits for Echelon Masonry products

Oldcastle Architectural Echelon masonry products as currently manufactured can be part of a strategy to earn points in the following LEED® v4 credits.

- Energy and Atmosphere
  - Credit - Optimize Energy Performance
- Materials and Resources
  - Credit - Building Product Disclosure and Optimization- Environmental Product Declarations (EPD)*
  - Credit - Building Product Disclosure and Optimization - Sourcing of Raw Materials
    - Option 2: Leadership extraction practices – recycled content
  - Credit - Building Product Disclosure and Optimization - Material Ingredients
    - Option 1: Material ingredient reporting including HPD*
  - Credit – Construction Waste Management
- Indoor Environmental Quality
  - Credit – Low-Emitting Materials
  - Credit – Acoustic Performance

* Based on planned publication in 2016.

Summary of LEED® credits for Belgard pavers

Belgard pavers as currently manufactured can be part of a strategy to earn points in the following LEED® v4 credits.

- Sustainable Sites
  - Credit – Rainwater Management
  - Credit – Heat Island Reduction
- Materials and Resources
  - Credit - Building Product Disclosure and Optimization- Environmental Product Declarations (EPD)
  - Credit - Building Product Disclosure and Optimization - Sourcing of Raw Materials
    - Option 2: Leadership extraction practices – recycled content, materials reuse (salvaged materials)
  - Credit – Construction Waste Management

Summary

Sustainable building design goes beyond the often narrow consideration of environmental impacts found in green building rating systems to also consider societal and economic factors. This report provides information on the many ways Oldcastle Architectural Echelon masonry and Belgard hardscapes' concrete masonry national product offering contribute to sustainable building designs. In addition, information on Echelon Masonry and Belgard hardscapes products as they relate to the new Materials and Resources credits found in LEED v4 is also provided.

LEED® and USGBC® are registered trademarks of U.S. Green Building Council.

References

1. *Green Building Assessment Protocol for Commercial Buildings©* (ANSI/GBI 01-2010), Green Building Initiative™, Portland, OR, 2010.

2. *International Green Construction Code* (IgCC™-2012), International Code Council, Country Club Hills, IL, 2012.

3. *LEED® Canada for New Construction and Major Renovation* 2009, Canada Green Building Council, Ottawa, Ontario, Canada, 2009

4. *LEED® v4 Building Design and Construction: New Construction and Major Renovation*, U.S. Green Building Council, Washington, DC, 2013.

5. *National Green Building Standard™* (NAHB/ICC 700-2012), National Association of Home Builders, Washington, DC, 2013.

6. *SITES v2 Rating System, For Sustainable Land Design and Development*, Green Business Certification Inc., Washington, DC, 2014.

7. *Standard for the Design of High-Performance Green Buildings Except Low-Rise Residential Buildings©*, (ANSI/ASHRAE/USGBC/IES Standard 189.1-2014), American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Atlanta, GA, www.ashrae.org, 2014.

About the Author

Christine "Tina" Subasic, P.E., LEED A.P. is a consulting architectural engineer specializing in masonry and sustainable design. Ms. Subasic has provided technical support services, including standards development, educational seminars, and inspection services in the masonry industry for over 24 years. She works with clients nationwide on development of technical brochures focusing on masonry and sustainability. She is active in ASTM Committees E60, C12 and C15, and participates on The Masonry Society (TMS) 402 subcommittee on veneer and glass block masonry and editorial subcommittee. She is editor of The Masonry Society's *Sustainability E-Newsletter*, and her work and dedication has been recognized by TMS as a recipient of the TMS President's Award and TMS Service Award.

She has written numerous articles and is the author of the books "Six-Minute Solutions for Civil PE Exam Structural Problems" and "Six-Minute Solutions for Structure I PE Exam" and co-author of the "Masonry Designers' Guide." Ms. Subasic received her Bachelor of Architectural Engineering Honors degree Structural Option from Pennsylvania State University. She is a LEED® Accredited Professional and a registered professional engineer in Virginia and North Carolina.